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CONTENTS

1. **Management**—Gas industry progress, business problems, statistics, government regulation, safety, personnel, education.....313

2. **Energy Supply and Economics**—Resources, reserves, and competitive applications of the fossil fuels and other sources of energy, including nuclear and solar energy.....320

3. **Natural Gas and Petroleum Production**—Geology, exploration, drilling, well management, reservoir engineering.....323

4. **Gas Conditioning and LPG Recovery**—Condensate, dust, CO_2 and sulfur removal, dehydration, odorization, oil fogging, humidification; LPG recovery and refining.....326

5. **Natural Gas Transmission**—Pipelines, compressors, dispatching, flow regulation, communications, maintenance.....327

6. **Gas and LPG Storage**—Holders, pressure tanks, underground storage; liquefaction, refrigerated storage.....331

7. **Manufactured Gas and Chemical Processing**—Gasification of coal, oil; reformed gas; chemical treatment; byproducts; synthesis gas production and conversion; petrochemicals; catalysts, catalyst development.....333

8. **Gas Distribution**—City utility systems: design, operation, maintenance; weather influence on peak loads and supply; LPG-air mixtures.....336

9. **Gas Fuel Utilization and Appliances**—Domestic, commercial, industrial; burners; combustion research; air pollution.....338

10. **Equipment and Instrumentation**—Production and handling equipment, and maintenance; computers; controls; measurement.....341

11. **Materials of Construction, and Corrosion**—Metals, refractories, plastics; corrosion measurement, prevention.....343

12. **Analytical Methods and Tests**—Standard and research techniques for gas-making materials, products, processes; instrumental analysis.....344

13. **Basic Science**—Chemistry, physics and basic engineering related to gas technology; physical properties of gases: phase equilibria, thermodynamics, reaction kinetics, heat and mass transfer, fluid flow.....347

Services Available to Readers—Photocopies, microfilm, Russian translations, bibliographies and literature searches, *Gas Abstracts on Cards*, back numbers of *Gas Abstracts*.....**Inside Back Cover**

Publications Abstracted for Gas Abstracts.....**Back Cover**

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1. MANAGEMENT

Gas Industry Management

Natural Gas Pricing—Problems of the Producer. R. Thompson. *Public Util. Fortnightly 64,* 567 (1959) Sept. 24 (6 pp.)

Author reports that the independent producers selling gas for resale in interstate commerce are afraid and very confused and do not believe that they are being treated fairly by the consumers and their representatives. Since the CATCO decision by the Supreme Court on June 22, the Transcontinental decision by the third circuit court of appeals on August 4, and the several decisions of the Federal Power Commission issued since August 10, most of the troublesome problems in advising producers concerning certificate applications have been solved even though the wisdom of some of the commission's recent decisions is highly debatable.

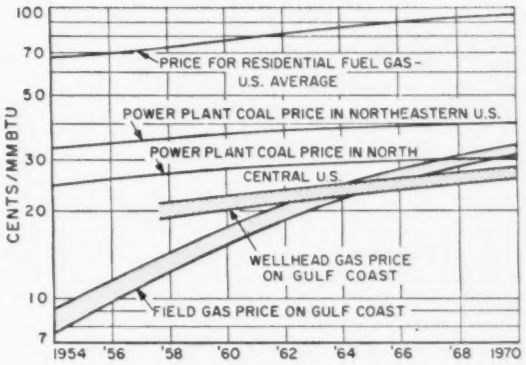
Natural Gas Pricing—Problems of the Consumer. K. H. Brown. *Public Util. Fortnightly 64,* 572 (1959) Sept. 24 (5 pp.)

Mythical figure, created by author, evolves from a series of adventures and concludes: 1) Everyone else's problems in natural gas pricing add up to and become his, and 2) those interstate pipelines are conduits to his doorstep of something more than natural gas. His resolution: To reconvert his heating equipment to oil, coal, electricity or peat as quickly as possible. For under present circumstances, consumer feels he is a sitting duck. Unless the Supreme Court reverses the "Bransco" case and sends a federal marshal to the offices of the Federal Power Commission with an order to put back the price to where it was unless records indicate otherwise, the sky is the limit and all problems in natural gas pricing evaporate. The mythical figure decided not to wait to see because no matter what the outcome, the wait would be expensive.

A Look Behind Natural Gas Prices. E. D. Redding. *Petrol. Refiner 38,* 293 (1959) Sept. (3 pp.)

Considering all factors, for the next ten years and beyond, the price of natural gas will be influenced and probably regulated by the price of coal. Coal reserves are adequate for perhaps another century. Trends and predictions made are subject to variations in the limits shown in the graphs, but the relative positions of the curves leave little doubt about the future prices of natural gas. The spread between the field price and the average residential revenue is shown to increase only slightly in the next ten years, largely due to the anticipated improved efficiencies of gas transportation. Virtually all of the factors mentioned which tend to increase the price of gas will be concentrated in the field prices of the gas. Answer is what many have forecast: Field prices and user prices are going to increase steadily.

Price Trends for Gas and Coal



(Adapted from *A Look Behind. . . .* left.)

Gas Industry Expansion

The Gas Industry Looks to New Horizons. J. T. Wolfe. *Public Util. Fortnightly 64,* 577 (1959) Oct. 8 (5 pp.)

Gas industry, under A.G.A. leadership, has begun to vastly expand its research program. The association's board of directors, acting on recommendations of Battelle Memorial Institute, has already approved the raising of $600,000 in additional PAR research funds in 1960. Coupled with the normal increase in research subscriptions, A.G.A. will be able to meet the $6 million budget recommended by 1965. Expanding market for gas service will require huge expenditures for providing facilities for production, storage, transmission and distribution. It is estimated that the nation's gas utility and pipeline companies will spend an average of nearly $3 billion annually in the next decade—going from $1.86 billion this year to $4.3 billion in 1970.

The Gas Industry's Contribution to the National Economy. H. Massey. *Public Util. Fortnightly 64,* 606 (1959) Oct. 8 (8 pp.)

With total assets now totaling $22 billion—or more than double what it was less than a decade ago—the natural gas utility and pipeline industries are firmly established as major contributors to the economy and social welfare of the U.S. On the basis of plant investment, the gas industry, now recognized as one of the nation's fastest-growing industries, has moved from sixth to fifth place among America's largest industries.

Winter Forecast: 1.2 Million More Gas-Heated Homes. *Gas Age 124,* 38 (1959) Sept. 17 (2 pp.)

With the advent of the 1959-60 heating season, gas utilities across the country are anticipating additional sales brought about by a predicted 1,286,000 new gas-heated homes on their lines. A.G.A. estimates that, by 1962, four million new gas house-heating customers will be added to the present total of 19 million. In the coming season, new homes are expected to account for 760,000 of the total, while conversions from other fuels will account for the remaining 526,000. A.G.A. notes that these figures represent dwelling units rather than units of gas heating equipment. Table included shows breakdown of the total by region and state for each of the next three heating seasons.

Planning for the Future in an Atmosphere of Change. H. R. Huntley. Paper CEP-59-1. New York: American Gas Association, 1959, $.25.

In a growing, dynamic business long range planning does not consist of making a long range plan which sets forth in a neat set of packages what amounts and types of service people will want and what instrumentalities will be used to meet these wants at some future date. This is true because 1) science and technology are changing so rapidly that nobody can predict what they will make possible in the future, and 2) people's wants and needs grow and change as economic conditions change and as means of fulfilling them advance, and nobody can predict what they will be in the future. There are two important facets in long range planning: 1) Determination of the direction in which progress can best be made based on the direction in which science and technology are moving and the direction in which people's wants and needs are moving, and 2) shaping the future in such a way as to best fit in with the planning which has been done for it.

Diary of an Industry. D. Hale and P. Loar. *Amer. Gas J. 186,* 21 (1959) Oct. (32 pp.)

Chronological history of the gas industry, beginning with 615 A.D. when gas wells were known in Japan to date, salutes the industry's 100th anniversary. Historical outline notes men who built the industry, ideas they developed, companies they organized, and abstracts of items from the pages of the "American Gas Journal."

Ratemaking

Rate of Return—The Utilities' Most Tilted Windmill. W. R. Connole. *Public Util. Fortnightly 64,* 594 (1959) Oct. 8 (7 pp.)

Higher costs not only of gas but of equipment, labor and money, as well as increased competition from other fuels, now harass the gas industry. Even higher rates of return do not provide a solution. The Federal Power Commission (FPC) has not rendered a definitive opinion on rate of return since the phenomenon of higher interest rates ceased to be merely a convenient arguing point in rate cases and became a permanent and uncomfortable fact of financial life. Actually, expert management methods are needed that include more sensible cost allocation and pricing principles.

Some Observations on the El Paso Decision. R. A. Rosan. *Public Util. Fortnightly 64,* 582 (1959) Oct. 8 (12 pp.)

On August 10, 1959, the Federal Power Commission (FPC) issued an opinion in the matter of the El Paso Natural Gas Co. This decision determines the jurisdictional rates of El Paso for the period April, 1955, through December, 1957. Since there are indications that the decision represents policy of the FPC with respect to the treatment of certain tax benefits, it has assumed special significance to the gas industry. It has further implications because of its effect upon the evaluation by managements of integrated companies such as El Paso to undertake exploration, development and production of natural gas.

Tailoring Gas Rates to the Customer's Needs. F. M. Banks. *Public Util. Fortnightly 64,* 601 (1959) Oct. 8 (5 pp.)

Ten years ago, the minimum charge portion of the rates applicable to most of the customers of the Southern California Gas Co. was $.90 for the first 200 CF of usage. Currently this minimum charge ranges from about $1.90-$2.30/month for the first 200 CF of usage. Although this is well under the $3 plus/month average customer costs, it is a king-sized step in the right direction. The value of this higher fixed charge in stabilizing earnings was vividly illustrated by what happened in the company in 1958, which was much warmer than usual.

Research

The Long Look at National Research Needs. A. V. Astin. *Anal. Chem. 31,* 21A (1959) Oct. (7 pp.)

Continued progress in space, missile and nuclear technology is hampered by lack of fundamental data on hot gases, plasma, and high temperature; high purity and precisely characterized materials; and high pressure and synthetic materials. With its increased budget, National Bureau of Standards is expanding its research on these new frontiers, according to the author who is director of the Bureau.

Gas Research. A Gas Industries Research Report. *Gas Ind. 3,* 1 (1959) Oct. (3 pp.)

In addition to the program being carried out under the PAR plan of the A.G.A., there are other re-

search activities that are contributing immeasurably to the growth of the gas industry. The industry's manufacturers spend millions of dollars each year to develop products for the natural and LPG markets. From these programs have come such developments as top burner heat controls, infrared burners, new gas refrigerators, new and better air conditioners, fold-down burners and many other items. Companies reported and their contributions are: Fisher Governor Co. (Iowa), research laboratory equipped to duplicate every conceivable field condition under which any Fisher product might operate; Maxitrol Co. (Detroit), development of system of electronic modulation for gas burners; Lone Star Gas Co. (Dallas), new concept in small heater design; Minnesota Mining and Mfg. Co. (Minneapolis), research in thermoelectric generation; Baso, Inc. (Milwaukee), flame powered control system, which is first commercial application for a thermoelectric generator using semi-conductor materials; M. B. Skinner Co. (Indiana), welding service fitting which would make its own tap by means of a punch or drill incorporated in the fitting; Eclipse Fuel Eng. Co. (Illinois), air-gas proportioning valve for manual or automatic operation and a machine which provides a simple adjustable source of premixed air/gas supply to combustion systems; and Caterpillar Tractor (Illinois), development of a high compression-ratio gas engine.

Gas Industry Research—For Peace and Better Living. H. Massey. *Gas Ind. 3,* 8 (1959) Oct.

Author briefly explains the thinking and circumstances which have made the gas industry the leader in the cooking, househeating and water heating markets, a leader among commercial and industrial fuels and a strong contender for leadership in refrigeration, incineration, air conditioning and laundry equipment. Most of the credit, says author, goes to research.

Research and Engineering Management and Control. S. R. Irish. Paper 59-SA-45. New York: American Society of Mechanical Engineers, 1959, $.80 ($.40 to members).

Attempt is made to show that research and engineering projects are susceptible to control techniques. After defining terms for common understanding of the discussion, the need for clear assignments is demonstrated not only for good management but also for use of the controls. The important characteristics of controls and their application are outlined with an actual example illustrating how the use of controls aids in the successful completion of complex research and engineering projects and represents one of the valuable tools of the manager.

American Gas Association

Today at the A.G.A. J. F. Ebdon and W. T. Harper. *Gas 35,* 77 (1959) Oct. (32 pp.)

Authors pay tribute to the achievements of the A.G.A. in comprehensive outline of the history of the organization. Chronological milestones of progress are included starting with the organization of the A.G.A. in 1918. Today, membership in the A.G.A. is held by some 377 operating gas companies out of the 1446 known to exist. Association membership represents better than 93% of the operating meters and 78% of the total U.S. pipeline gas reserves. In addition, 592 manufacturers, eight holding companies, nine service companies, 47 associates and about 8000 individuals hold A.G.A. memberships. By means of the organizational chart, authors outline functions of the various departments within the A.G.A.

Federal Power Commission

The Federal Power Commission and the Economic Analyst. R. B. Eckles. *Public Util. Fortnightly 64,* 614 (1959) Oct. 8 (9 pp.)

Present Federal Power Commission (FPC) has a few professional economists as staff members. They are not generally used as economists, or at least their professional skills are not applied to the problems discussed in the article. It seems to be unwise to assert that the engineer, or the accountant, or the lawyer, no matter how well-read and how experienced, can have quite the point of view of the trained economist. The staff and members of the industry are forever working around and over a basic problem—where management begins and regulation stops. Perhaps common sense might indicate that the economist might help out both parties by showing where regulation hurts efficient management and vice versa. He might serve as the alarm bell, pointing out to both that the zeal for interpretation and application of public utility concepts has entered an area of unreality or that service to the public has been dangerously neglected for the interests of the shareholder.

The Unnatural Problems of Natural Gas. R. A. Smith. *Fortune 40,* 120 (1959) Sept. (12 pp.)

Author believes that gas industry is burdened with problems of bureaucratic lassitude, internal confusions and uncertainties. He further asserts that none of the 1300 distributors who are dependent on interstate gas can confidently make the business decisions upon which systematic growth depends so long as the Federal Power Commission (FPC) shirks its statutory responsibility of regulating the price of gas in the interests of the consumer. None of the 100-odd interstate pipelines can know with any certainty

what its past or future earnings may be until the FPC sets up a new yardstick for profits and gets cracking on a backlog of well over 2000 unsettled pipeline-producers rate cases. None of the 150 major producers can be sure how well they will do on their interstate sales, which represent over half of all the gas put on the market; after five years the FPC has still to come up with a formula for regulating producer prices. On those few occasions when the FPC has made a decision, nobody has had any assurance that the decision was in the right direction. Last year courts of appeal reversed more than half of the commission's contested orders. And this year, the Supreme Court unanimously upbraided the agency for having approved a new high price for gas producers on "insufficient evidence." Author critically analyzes a vexing problem.

Federal Power Corporation

The Federal Power Corporation—A Pattern for Nationalization. F. X. Welch. *Public Util. Fortnightly 64,* 473 (1959) Sept. 24 (13 pp.)

Regional nationalization of the electric power industry, the long-range goal of a potent left-wing political coalition, received a powerful impetus with the recent enactmant of the precedent-making TVA revenue bond legislation. But there are other measures—including the proposed Bonneville Power Corporation now pending in Congress—which suggest that the federal power corporation could be an effective vehicle for ultimate nationalization of the power industry. Final feature of the Bonneville bill is the key to the entire plan for federal domination of this area: Method of financing the corporation by means of revenue bonds. Without easy access to huge reservoirs of cheap money, unfettered by the process of annual congressional appropriation, the creation of a corporation as a substitute for the present power administration would have little meaning. While the proposed revenue bond follows the new TVA-financing pattern in many recognizable principles, it varies from it considerably in details and methods.

Natural Gas

The Natural Gas Industry. H. W. Springborn. (Garden City, N. Y.: Nelson Doubleday, Inc., 1959.)

Descriptive pamphlet, written in laymen's terminology, covers all phases of the natural gas industry, including the history of natural gas. Applications, pipelining, storage and exploration techniques also are discussed.

Russian Gas Industry

Russia Maps Gas Plans. *Oil Gas J. 57,* 80 (1959) Sept. 14 (2 pp.)

Because Russians are pushing the Central Asian-Ural pipeline project (the pipeline system is designed to move to more than 2,000,000,000 CF/day of gas) it is evident that they believe they have found "almost inexhaustible" supplies of gas in the Bukhara-Khiva depression of western Uzebekistan. The first small section of the line from Jarkak field across the Kyzyl-Kum desert to Bukhara was finished late last year. Experience is certain to help them, the Russians say, in laying two 40-in. gas lines from the big new Gazli field near Bukhara to the Ural mountain metallurgical centers of Chelyabinsk and Sverdlovsk. Survey work is well under way. The Gazli-Chelyabinsk line is scheduled for completion sometime between 1960-3. It will be 1300 miles in length. The line to Sverdlovsk, slated for completion about two years later, will cover 1400 miles. The Russians claim Gazli, Jarkak, Mubarek and other gas fields of the Bukhara-Khiva depression have three times the gas reserves of the much-publicized Stavropol fields of the northern Caucasus.

Customer Service

Good Customer Service Starts with Order Taking. E. L. Vervoort. Paper DMC-59-7. New York: American Gas Association, 1959, $.25.

Outline of program used by the Customers Service Department of the Brooklyn Union Gas Co. Included in the paper are indoctrination, personalized training, classroom training, group discussion, performance checking, advanced technical training, field training, developing teamwork, opportunity for sales leads and written communications.

Quality Control in Customer Service. G. S. Coates. *Amer. Gas J. 186,* 25 (1959) Sept. (4 pp.)

Author outlines purpose of work inspection as 1) determination of which personnel were doing satisfactory work; 2) effectiveness of current training and the areas in which further training is needed; 3) general acceptance of company's service policy by its customers and their feeling toward the company, and 4) determination of whether all service policies, procedures and methods make good sense. Program has improved employee morale, made employees more conscientious of their work and enhanced customers' impression of service.

Daily Workload Forecasting and Manpower Planning. M. J. Belensky. Paper DMC-59-3. New York: American Gas Association, 1959, $.25.

Methods and personnel used by the Philadelphia Gas Works in carrying out its service work for its customers. Work completion schedule, workload and manpower coordinator, general procedure for manpower allocation, estimating available orders for next day routes, capacity for "phoned-out" work, estimated "phoned-out" workload, night details, Sun-

day and holiday details, and Saturday work force are the items covered.

Air Conditioning Service—Industry Experience. G. K. Bachmann. Paper DMC-59-24. New York: American Gas Association, 1959, $.25.

Topic was conceived as a statistical presentation of recent service call experience, together with pertinent information on the mechanics of handling service calls. It is not designed as a technical discussion of the effect of service adjustments on air conditioner operation. Paper is a Customer Service Committee report in that it is largely a summary of operating data provided by the individual companies represented on the Committee.

Cost Accounting

Accounting for Oil and Gas Producers. Principles, Procedures and Controls. C. A. Smith and H. Brock. (Englewood Cliffs: Prentice-Hall, Inc., 1959.) 536 pp., $8.00.

Descriptive and critical work provides a realistic picture of present-day accounting practices. This book was written to meet the ever-growing demand for a balanced treatise on present-day financial accounting principles, practices, policies and procedures used by oil and gas producers. The scope necessarily includes topics not directly related to accounting. To achieve the book's descriptive and critical nature, the authors have presented the more important variations of accounting practices found in use today with arguments for and against each. Book is realistic because detailed information on accounting practices was secured through direct contacts and visits to more than 60 oil companies, small and large. Suggestions for the draft of five chapters were prepared by oil company officials and employees directly engaged in activities presented in those chapters. In addition, company accounting and procedural manuals were studied. Book is divided into 24 chapters and six appendices. The first four chapters deal with economics of oil and gas production and operation, geological and geophysical aspects of petroleum production, drilling and producing operations, and organization and work of the exploration and production department. These logically lead to the fifth chapter, the accounting organization. Then the book becomes specific and detailed, dealing with topics such as accounting policies and practices, property interests and special contracts, general principles for plant and equipment, acquisition of undeveloped properties, the producing properties ledger, cost of crude oil and gas produced, revenue from oil and gas production, depreciation, special problems in producing natural gas and financial budgets and forecasts, among others. The appendices are specimens of various types of leases of interest to oil and gas producers. Written in laymen's terms, the book should serve as a valuable aid to those concerned with accounting procedures.

Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants January-December 1958. S. Katell, J. H. Faber and J. W. Douglas. *U.S. Bur. Mines Info. Circ. 7916.* (Washington: U.S. Govt. Print. Off., 1959, $.40.)

Report represents the sixth of the series on "Bibliography on Investment and Operating Costs for Chemical and Petroleum Plants," and is concerned with articles published during the period designated. Most articles are concerned with cost data. However, several discuss various aspects of cost estimating procedure or operational plant data.

Public Relations

The Star Salesman—The Serviceman. J. MacLarty. Paper DMC-59-5. New York: American Gas Association, 1959, $.25.

Author believes that the customer who buys a gas appliance does not really care how large the company is. He does not care how many miles of pipe are in the ground or what is in a modern gas plant. The customer is interested in one thing only—how gas can serve him and serve him better through this appliance. When he buys the best service, he has a right to expect no interruption in this service. This means that the service he gets from his appliance necessarily includes service he gets with it. This is where the service department enters the picture. Importance of the role of the serviceman is outlined.

LPG

Rise in Most End-Uses Boosted Liquefied Petroleum Sales 8%. *Gas Age 124,* 28 (1959) Sept. 17 (4 pp.); **U.S. Reports LP-Gas Sales Rose 8% in 1958.** *LP-Gas 19,* 50 (1959) Oct. (2 pp.)

Domestic sales of liquefied petroleum gases, excluding use in gasoline, increased 8% in 1958 to 7,462,089 thousand gallons, according to a survey by the Bureau of Mines. In 1957, sales rose 5% to 6,939,121. LPG sales for each end-use category showed an increase in 1958 with the exception of raw material for synthetic rubber components, which declined 11% compared with 1957. Sales for domestic and commercial use, the largest end-use category, showed a gain of 7%. Other increases were: Industrial, 12%; combustion, 6%, and chemical, 10%. Use in manufacture of gas increased 3.4%. Refinery fuel consumption was reported as 179,231 thousand gallons, an increase of 47% over 1957.

Pipeline Operations

Relative Costs of Transmission of Pipeline Gas. C. G. von Fredersdorff. Paper CEP-59-18. New York: American Gas Association, 1959, $.25.

Relative transmission costs compared to natural gas are estimated for five different pipeline gases, 800-900 Btu/SCF, 0.45-0.62 specific gravity, obtained from coal gasification-methanation, coal hydrogasification and oil shale hydrogasification. The calculations are based on a 20-in. OD, 1000 psig, 500-mile pipeline delivering 150-220 MMSCFD of high-Btu gas or 440-540 MMSCFD of hydrogen. Pipeline and compressor station investment costs, fixed charges and operating expenses are derived from manufacturers' published information. Compressor fuel costs are computed separately for each case, based on the actual power requirements and unit fuel costs at 12.5¢/therm. The total transmission costs are expressed on a common basis as ¢/MMBtu/100 miles transmitted.

Appliance Standards

Follow-Through on Improperly Installed Appliances. D. M. Baker. Paper DMC-59-28. New York: American Gas Association, 1959, $.25.

Through the medium of a questionnaire mailed to all members of the A.G.A. Customer Service Committee, a resume was asked of each company's methods and procedures when an appliance is found to be installed and operated in a manner considered hazardous. The returns from the 24 companies contacted indicate that the industry generally is employing like procedures in following through on improperly installed appliances. This similarity is as it should be when it is considered that gas company operations are generally governed by the same basic rules and regulations. Questions asked were: What conditions are observed and checked by service personnel; what yardstick or standard is used for determining unsafe conditions; what methods and procedures are employed when potentially or obviously unsafe conditions are found?

Petrochemicals

Chemical Forecast 1964. A. R. Kavaler, ed. *Oil, Paint and Drug Reporter* (Sect. II) (1959) Sept. 28 (60 pp.)

Chemical Market Research Association measures the growth potential of seventeen key chemical process materials for the next five years. Areas covered include aromatic solvents, nitrogenates, polymer chemicals, the alcohols, ethylene chemicals, inorganic chemicals and miscellaneous organics.

Personnel

Selecting, Training and Testing Distribution Welders. G. G. Dye. DMC-59-1. New York: American Gas Association, 1959, $.25.

Outline of program used by Southern California Gas Co., Los Angeles. Welding training and testing program described is quite satisfactory in meeting the company's particular needs. Of 355 periodic tests given contract welders in the field in 1958, there were only 12 instances where welds did not meet the standards outlined by the author. Only 15 out of 275 company welders required more than the minimum eight hours of brush-up training. In addition since instituting this plan which encourages employees to learn welding on their own, the time necessary to train welders has been reduced by an average of 60 hours, from 320 hours to 260 hours average. Thus while other companies may have equally effective programs or programs that better meet their conditions, Southern California is confident that it is getting high quality welding at a reasonable cost for training and testing.

Foreign Activities

Cwm Coking Plant. A Review of the N.C.B.'s New Development in Glamorgan. C. J. P. deWinton. *Gas J. 299,* 329 (1959) Sept. 23 (8 pp.)

Description of new coking plant at Cwm, near Pontypridd in Glamorgan (South Wales). Carbonizing plant consists of four batteries grouped in two pairs, each of 27 ovens and divided by a single coal service bunker placed centrally. Ovens are the Simon-Carves underjet compound type with a single waste gas flue. High grade silica has been used in their construction. A total throughput of between 1350 and 1530 tons of coal/day can be carbonized. Coal for carbonizing comes from the adjoining Cwm colliery where it is washed in a Chance washery to an ash content of between 4½-5%. Complete coal and coke handling, byproduct recovery, oxide gas purification and grid compressor station are provided.

Education

Training and Up-Grading Street Department Personnel. D. A. Cozzens. Paper DMC-59-12. New York: American Gas Association, 1959, $.25.

Training and up-grading of personnel has become an increasingly important part of the rapidly expanding gas industry. Operating experiences of the present day gas industry seem to indicate an almost never ending need for technically trained personnel in both the physical and clerical groups. Paper illustrates an approach to the problem of training and up-grading physical personnel by outlining methods and facilities currently in use in the Underground Lines

& Mains Department of the Long Island Lighting Co., N. Y.

Safety

Safe Practices in Stand-By Plant Operations. C. L. Pendleton. Paper CEP-59-51. New York: American Gas Association, 1959, $.25.

Standby plant differs from shutdown plant in that it is one that should be able to start production on short notice. Problem areas in standby plants are preventive maintenance and training. Paper discloses ways and means to overcome these problems.

Beware Process Explosion Hazards. R. B. Jacobs, F. H. Blunk and F. W. Scheineman. *Petrol. Refiner 38,* 361 (1959) Sept. (8 pp.)

Brief outline of methods of hazards analysis is presented. Contrary to common belief, an analysis of hazards does not necessarily lead to the expenditure of more money. In fact, careful study of a problem often results in the elimination of expenditures for certain features that at first seem necessary. Most industrial activities involve the element of risk, of possible loss of capital equipment from collision, fire or explosion. Factors other than economics enter into the decision of how much can be expended to prevent disasters. However, the economics of a disaster situation is an important consideration which can be handled by balancing the probable cost of a potential disaster against the cost of its prevention. If the former is substantially greater than the latter, expenditures for prevention are indicated. If, however, cost of prevention outweighs the probable cost of a potential disaster, it may be good business to take the risk.

Chemical Process Safety. G. L. Gorbell. Paper 59-SA-21. New York: American Society of Mechanical Engineers, 1959, $.80 ($.40 to members).

Chemical process safety as it relates to the conditions which sometimes cause serious, and often spectacular accidents, is discussed. These accidents often give the chemical industry an undeserved "bad" name in the eyes of the public. Measures to control and eliminate these undesirable conditions are set forth and discussed.

Automatically Fired Boilers in Industry Need Some Attendance. W. B. Parker. *Combustion 31,* 57 (1959) Sept. (4 pp.)

Based upon the experience of the company, the need for some degree of attendance on automatically operated boilers is obvious. Studies of accident-cause-analysis statistics for the years 1956-7 show that 46.9% of the insured accidents (excluding furnace explosions) to high pressure steel fire tube boilers were the result of inadequate testing and maintenance of control devices. During 1958, this figure increased to 52%. The 1956-7 statistics on furnace explosions also are significant. They show that 20.9% of the furnace explosions on oil-fired boilers and 21.5% on gas-fired boilers were due to failure to test and maintain their control devices. Therefore, while automatic operating and control devices have been developed to a high degree of operating efficiency and dependability they are still subject to failure, and some attendance is necessary.

The Operators Report on Safety in Air and Ammonia Plants. *Chem. Eng. Progress 55,* 49 (1959) Sept (6 pp.)

On December 13, 1957, at about 4:15 p.m. an explosion and fire occurred at the ammonia plant of the Dow Chemical of Canada Ltd., in Sarnia, Ont., which destroyed the hydrogen purification unit. Two men were fatally injured and one man was seriously burned. Report of roundtable discussion of the accident.

Space Heating

Outside Business Looks at the Heating Industry. J. Tolman. *Gas Heat and Comfort Cooling 10,* 25 (1959) Oct. (3 pp.)

One of the country's larger corporations spent a good part of this year analyzing the heating industry in its search for another field in which to invest production capacity and money. Its report contains some fresh views, as well as some fairly widely recognized observations and a market forecast. Article, based on this report, shows industry just how it looks to outside business with money to invest.

Maintenance

Industrial Practice in the Care of Standby Production Equipment. D. A. Dundore. **Bibliography on Standby Storage and Maintenance of Gas Manufacturing Equipment.** O. P. Brysch and C. A. Simms. Paper CEP-59-50. New York: American Gas Association, 1959, $.25.

Summarization of answers to questionnaire sent to operators throughout the U.S. on maintenance of standby production equipment. Questionnaire dealt with all types of production equipment which may be left idle for many months at a time, but maintained in constant readiness, so that gas could be produced either to meet emergencies or for peak shaving purposes. An attempt was made to subdivide the plants and roughly separate maintenance from operating. In conjunction with this, a literature search was conducted, and a bibliography containing 61 citations is included.

How to Get the Most Out of Electrical Controls. H. A. Wright. *Pipe Line Ind. 11,* 59 (1959) Sept. (5 pp.)

Article outlines what to look for when trouble-shooting electrical controls and how to maintain them. Because controls are so reliable, they are often slighted. This can sometimes lead to "chain reaction"-type difficulties. Solution is to establish a scheduled maintenance program and to train men for prompt trouble shooting. Sample control trouble-shooting chart is included.

2. ENERGY SUPPLY AND ECONOMICS

Energy Sources

Effect of Heating Value and Specific Gravity on the Overall Economics of Gas Production, Transmission and Distribution. M. A. Elliott. Paper CEP-59-16. New York: American Gas Association, 1959, $.25.

The Manufactured Gas Production Planning (M.G. P.P.) Subcommittee was requested to determine a study the objective of which is to guide research and development work on gas production processes that may be used in the future to make supplemental gas from coal or oil shale. Any process under development can be designed to produce a gas containing methane mixed with small quantities of nitrogen and having a heating value very close to 1000 Btu/SCF. However, this may require additional processing steps with resulting increases in gas production costs. Since the cost of gas production will be affected by the heating value and specific gravity of the gas produced, it is desirable to determine, if possible, the gas production process that would give the lowest over-all cost of gas at the point of consumption. This determination involves consideration not only of production costs but also of transmission and distribution costs. It is the purpose of this paper to outline some of the factors that are important in arriving at a solution of this problem.

Assessment of Energy Requirements for India. *Quarterly Bull. Central Fuel Research Inst. 8,* 106 (1958) Dec. (10 pp.)

India's huge population of 380,000,000 human beings has been estimated to be able to supply energy equivalent to a bare 10 million tons of coal. Even if all the animal energy is taken into account, the total animate effort is equivalent to only 76 million tons of coal. From a consideration of the fact that the Indian consumption of (commercial) energy is only 0.1 ton of coal equivalent per head per year and that the U.S.A. uses 10 tons of coal equivalent per head per year, it is obvious that energy consumption and standard of living are inextricably bound together. During the third five year plan (1961-5), the coal requirements are assessed at approximately 155 million tons if the standard of living is to be raised. Article discusses problems, production and sources of the energy requirements.

Fuel Cells

Fuel Cells Will Be on the Market Soon. *Petrol. Week 9,* 68 (1959) Sept. 25 (2 pp.)

Major breakthrough in the development of the fuel cell may be expected in the not too distant future. Instead of hydrogen, it will be possible to use gaseous, liquid or even solid fuels—less costly, easier to obtain and easier to store. Breakthrough date, still a matter of conjecture, is estimated within about two years. There are two basic categories of fuel cells at present: Those that operate at normal temperature, and those that operate at high temperatures. The difference in operating temperatures has, heretofore, largely controlled the scope of fuels that the fuel cell can utilize. The high-temperature cells were capable of using, with reasonable success, a greater number of fuels. Use of methanol and various other alcohols as fuels for the cell is attracting considerable attention. Low-temperature fuel cells are likewise capable of making use, as fuels, of a great number of ionizable materials. But their electrodes must be treated with the proper catalyst. Refiners are taking an active interest in these developments, which may result in the selection of a petroleum product as the most adequate and economical fuel for the fuel cell.

Significance of Fuel Cell Research to the Gas Industry. R. B. Rosenberg. Paper CEP-59-20. New York: American Gas Association, 1959, $.25.

Promising means for improving the conversion of chemical energy into work is the fuel cell, an outgrowth of the electrolytic or galvanic cell, which converts chemical energy directly into electrical energy. While research has been centered on three basic types, i.e., direct, indirect and redox, recent work has been centered on indirect cells. This cell uses a gaseous fuel, such as H_2, CO or CH_4, which is caused to diffuse through an inert electrode. At the present stage of fuel cell development, it does not appear feasible to expect to attain both a high power output per unit volume and a high efficiency. Development of a practical natural gas cell would be most desirable. However, the development of cells operating on hydrogen-carbon monoxide mixtures or process hydrogen may be almost as desirable. It may be feasible to distribute these fuels centrally from natural gas conversion installations. Alternatively, natural gas may be supplied to individual natural gas reforming fuel cell units. Indica-

tions are that it may be attractive in the future for the gas industry to become the prime energy supplier for several types of fuel cell applications.

Gas Reserves

Calculation of Gas Reserves from Gas Density Data. W. H. Mensch. *Petrol. Eng. 31,* B-49 (1959) Sept. (4 pp.)

Method that eliminates at least seven separate calculations and reduces time and effort by some 50% with no loss of accuracy would be extremely helpful in computing natural gas reserves, especially where a large number of these computations are required. Use of gas density charts as determined by M.B. Standing provides such a method, and is the basis for the formulas and computations derived and described in the article.

Canada' Top Oil-Gas Expert Is Named Energy Boss. *Oil Gas J. 57,* 72 (1959) Sept. 14 (2 pp.)

Ian N. McKinnon, chairman of Canada's new National Energy Board, carries a backlog of prestige to his new post. Presiding over Alberta's Oil and Gas Conservation Board since shortly after the oil boom started at Leduc in 1947, he carried out his duties to the satisfaction of both his government and the industry over which he exercised so much influence. While chairman he heard applications for permission to export massive quantities of natural gas from Alberta to the U.S. Three key applications from Westcoast Transmission Co. Ltd., Trans-Canada Pipe Lines Ltd., and Alberta & Southern Gas Co. were approved. Now, as chairman of the energy board, McKinnon will soon be dealing with applications for national permits from the same three companies. In the export of energy sources the permission of both the province of origin and the federal government is necessary.

Petroleum

World Oil Demand to Exceed 20 Million Barrels Daily in 1959. *World Petrol. 30,* 50 (1959) Sept. (2 pp.)

World demand for petroleum is expected to increase 6.9% in 1959 to 20,477,100 bbl/day of crude oil and natural gas liquids. The prospective increase of 6.9% or 1,316,100 bbl/day compares with a growth in demand of 985,000 bbl/day or 5.1% in 1958. Western hemisphere consumption is expected to rise 5.1% this year, while the eastern half of the world will continue to do almost twice as well with a prospective rise in demand of 9.4%. The eastern hemisphere rise is from a small base but the differential is decreasing every year. This year 41.2% of the world's demand for oil is in the eastern hemisphere compared with 29.5% ten years ago.

Jersey to Merge Humble, Carter, Esso. *Oil Gas J. 57,* 96 (1959) Sept. 7 (2 pp.)

Standard Oil Co. (N.J.) has instituted action regarding long-talked-of plans to merge not only Humble Oil & Refining Co. and Carter Oil Co., but also to include Esso Standard Oil Co., and two small marketing subsidiaries, Oklahoma Oil Co. and Pate Oil Co. If and when the merger is accomplished, it will mean one giant domestic company which will handle all of Jersey's exploration, production, refining and marketing activities. Humble will be the surviving name, but the new company will be incorporated in Delaware, rather than Texas. Research will continue to be handled under separate subsidiaries, Esso Research & Engineering Co. and Jersey Production Research Co.

Petroleum Reserves

Petroleum Reserves and Oil Shale Deposits. C. C. Anderson. *Producers Monthly 23,* 32 (1959) Sept. (4 pp.)

Possible use of nuclear explosives in the production of petroleum and in recovering oil from oil shale is discussed. Broader interest has been expressed by the petroleum industry, also, for using energy from atomic reactors and radioactive waste products in the production of oil and gas. Results of the first underground nuclear detonation designed to be fully contained (the Rainier Test, September 19, 1957) and preliminary results of four nuclear underground tests detonated in October, 1958, are discussed.

Pint-Sized Kuwait Has Some Texas-Sized Oil Wells. P. Swain. *Oil Gas J. 57,* 118 (1959) Sept. 21 (4 pp.)

If it were not for worldwide depressed crude market conditions, Kuwait could well take over the No. 1 oil-exporting spot from Venezuela. For example, production from its 300 wells almost matches Venezuela's 9200-well output. Following the worldwide trend that has spread to the Middle East, Kuwait will start reinjecting gas into its producing formations by the end of 1960. At present gas from the separators that can be used in Kuwait town and Ahmadi for domestic and industrial uses goes to these two sources. But the amount is small. The remainder is flared in the desert as waste. Kuwait Oil Co. now is building a new injection plant in Burgan to put 100,000 MCF of this flared gas back into formation.

Foreign Activities

Sino-Soviet Plans for Oil and Gas. What Chance for Success? A. Gakner. *World Petrol. 30,* 60 (1959) Sept. (4 pp.)

Author discusses trends in petroleum exports, current rate of production and petroleum goals as back-

ground for his thesis on the success of the plans for oil and gas. He points to the highly specialized geologists, technologists and engineers who are annually graduated from the country's petroleum institute, the scientific research organizations that are continually developing better ways of drilling and recovery, expected doubling of primary refining capacity in the next seven years; increased catalytic cracking capacity (4.3 times) and catalytic reforming (16-18 times) during the same period; several thousands of miles of new pipelines as measures to achieve the objective. Yet, problems continue to mount, and these problems also are discussed.

Six Years of Exploration in the Sahara. A. Charon. *World Petrol. 30,* 42 (1959) Sept. (4 pp.)

Outline of the forming of the Compagnie des Petroles d'Algerie, the geological background of the CPA concessions, the working conditions in the Sahara and the discoveries that have been made.

Peak Shaving

Peak Shaving Versus Winter Natural Gas Service—A Method for Determining the Most Economical Combination. D. B. Seifried. Paper CEP-59-9. New York: American Gas Association, 1959, $.25.

Each specific problem in peak shaving economics must be analyzed on its own merits. Results of a specific analysis will depend upon the supplier's contract-demand and winter service rates, including the effect, if any, of load factor limitations or minimum charges. It will depend also upon the cost of producing peak shaving gas including, where applicable, fixed charges on new capacity investment, upon the normal weather pattern for the area served, and upon the extent of valley gas markets. In many instances it will be found that there is a combination of peak shaving production and winter natural gas service which will result in better economics than either source alone.

Steam Generation

Central Station Design Survey. *Power 103,* 179 (1959) Oct. (12 pp.)

Representative design and construction trends in late 1958 and early 1959 are presented. Tabulations include conventionally fueled and nuclear plants. Design data on conventional steam plants are the most complete that can be had for units planned, under construction and starting operation. The number of design features reported per plant is, as in last year's survey, double that reported earlier.

Coal Gasification

Some Comments on Probable Future Costs of Synthetic Pipeline Gas. R. G. Minet. Paper CEP-59-52. New York: American Gas Association, 1959. $.25.

Future cost of manufactured pipeline gas from coal is a topic that has been widely discussed for a number of years by various authorities in the gas industry. Paper assembles information that has been published in an attempt to use these data as a basis for a calculation of the cost of manufactured pipeline gas in 1978. Value of work rests clearly in the matter or orientation.

Thermoelectricity

Materials for Thermoelectric Refrigeration. F. D. Rosi, B. Abeles and R. V. Jensen. *J. Phys. Chem. Solids 10,* 191 (1959) July (10 pp.)

Electrical conductivity, thermoelectric power and thermal conductivity were measured on Bi_2Te_3 and the alloy systems $(Bi,Sb)_2Te_3$, $Bi_2(Te,Se)_3$ and $(Bi_2Sb)_2(Te,Se)_3$. Criteria determining the optimum properties of the materials for thermoelectric refrigeration are discussed. Thermocouples made up of the above materials have yielded a maximum cooling corresponding to a temperature difference of 65° C between the hot and cold junctions, with the hot junction at 300° K.

Offshore Operations

Drilling from Floating Vessels Now Economically Carried Out Off California Coast. W. W. Rand. *J. Petrol. Tech. 11,* 35 (1959) Sept. (2 pp.)

Deep water occurs at short distances off the California coast, restricting the economic use of artificial islands and bottom-based platforms to a narrow coastal strip. Beginning in 1950, drilling from floating vessels has proved to be feasible and economically sound, and operators are now seeking methods of drilling oil wells from vessels. Significance of the results so far achieved has made little impression on the industry, but extension of techniques now in use forecasts widespread use of floating drill rigs.

Competitive Energy

Coal Heat's Stoker Album. *Coal Heat 76,* 5 (1959) Sept. (27 pp.)

Pictures and data on stokers produced by 25 leading manufacturers of industrial, commercial and domestic units.

Water

Sea Water Distillation with By-Product Power at Aruba. G. E. Sonderman. Paper 59-SA-24. New York: American Society of Mechanical Engineers, 1959, $.80 ($.40 to members).

Description of the engineering and economic features of the world's largest single installation to sup-

ply fresh water from the sea: The new $10,600,000 distillation plant on the Island of Aruba in the Netherlands West Indies. This plant is the first to generate inexpensive power as a byproduct of the distillation process. The opportunities for the power industry to explore and develop the combined water-electricity type distillation plant are discussed.

Fuel Cells

Direct Production of Electrical Energy from the Oxidation of Fluid Fuel. E. Justi and A. Winsel (assigned to Ruhrchemie AKG and Steinkohlen-Elektrizitat AKG.) U.S. 2,901,523 (1959) Aug. 25.

In a porous electrode fuel cell, using fluid fuels and oxygen, an improvement is claimed comprising a porous partition placed between the spaced electrodes to prevent oxygen bubbles from contacting the fuel electrode.

Method for Generating Electrical Energy from Electrochemical Combustion of Fuel Gases. E. Gorin and H. L. Recht (assigned to Consolidation Coal Co.) U.S. 2,901,524 (1959) Aug. 25.

In the method of generating electrical energy through electrochemical combustion of fuel gases with oxygen in an electrochemical cell containing two gas passageways separated by an oxygen-transferring electrolyte comprising carbonate and having a first electrode surface which is in communication with fuel gases from one gas passageway and a second electrode surface spaced from the first and being in communication with oxygen-containing gas from the other passageway, the improvement comprises removing carbon dioxide from the fuel gases by absorption on a solid particulate acceptor, recovering carbon dioxide from said solid particulate acceptor by passing the oxygen-containing gas through said acceptor whereby carbon dioxide is released and commingled with the oxygen-containing gas in the oxygen-containing gas passageway, and recovering electrical energy from the two electrode surfaces.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Air Drilling

Air Drilling 85% Successful 226-Well Survey Indicates. G. Jackson. *Drilling 20,* 114 (1959) Sept. (2 pp.)

Survey of air drilling operations over 18-month period shows that out of 226 wells, 63% encountered various degrees of fluid invasion in the bore hole. Water entry was successfully overcome in 48.7% and the drilling was carried to the projected depth (over 10,000 ft in some cases.) Average cost per foot of air as computed in the six-state survey (total footage—419,407) is $1.37 or $.92/ft exclusive of standby charges. Where no water was encountered the footage cost sank to $.77/ft or $.51 less standby. In planning an air drilling program, the proposed costs for air can be expected to achieve savings in rig time, testing time as well as reduce overhead and administrative costs due to over-all time saving.

Drilling

Phenomena Affecting Drilling Rates at Depth. A. J. Garnier and N. H. van Lingen. *J. Petrol. Tech. 11,* (T.P. 8080) 232 (1959) Sept. (8 pp.)

Rock downhole is known to be less drillable than when brought to the surface. This must be ascribed mainly to the presence under downhole conditions of a pressure differential across already made chips, which hinders their being lifted. The pressure differential has partly a static and partly a dynamic origin. Balling-up of bits is another consequence of this pressure differential.

Drilling Muds

Extreme-Pressure Lubes in Drilling Muds . . . What Do They Offer? W. C. Browning. *Oil Gas J. 57,* 213 (1959) Sept. 21 (5 pp.)

Advantages include: Longer life for bits; prevention of wall sticking of drill string; longer downhole torque; reduced wear on reciprocating parts; protection from corrosion damage, and good lubrication in highly inhibited muds and in water-base muds generally.

New Drilling Fluids Harden Shales. W. J. Weiss, W. L. Hall and R. H. Graves. *Oil Gas J. 57,* 147 (1959) Oct. 5 (7 pp.)

Shale-control muds have effected savings in many ways: Reduction in use of barite, simplification of control, reduction of warehousing and logistic problems, and even reducing the amount of water consumed. Moreover, these new drilling fluids have made it possible in many cases to drill shale sections which probably could not have been drilled successfully otherwise. New fluids stabilize the formation by chemical means. For this reason, preparing and maintaining them must be based primarily on chemical standards.

Geology

Third Symposium on Rock Mechanics. *Quarterly of the Colorado School of Mines 54,* (1959) July (366 pp.) (Golden, Col: $3.00.)

Papers and discussion from the third symposium on

Rock Mechanics held at the Colorado School of Mines, April 20-22, 1959. General theme was to stress the broadness of the field of rock mechanics and the fact that it is of interest to men representing a great variety of professional fields—that of mining, engineering, civil engineering, of geology, of military engineering and the field of the physicist, among others. Thus the sessions entered into the fields of crushing or comminution, of soil mechanics, geophysics and nuclear blasting, all of which lie within or are related to the field of rock mechanics. Papers presented are included.

Logging

Velocity Logging: A New Family. H. Itten. *Petrol. Eng. 31,* B-35 (1959) Sept. (7 pp.)

Principle of measuring sound waves traveling through the earth's formations, long applied in seismology, is "borrowed" for new applications in oil well logging . . . permitting one log to benefit engineer, geologist and geophysicist.

Reservoir Engineering

Calculation of the Stabilized Performance Coefficient of Low Permeability Natural Gas Wells. F. H. Poettmann and R. E. Schilson. *J. Petrol. Tech. 11,* (T.P. 8081) 240 (1959) Sept. (7 pp.)

Direct determination of the stabilized performance behavior of low capacity, slowly stabilizing gas wells is extremely time-consuming and wasteful of gas. From both field experience and theoretical calculations, a test procedure has been evolved by which the stabilized back pressure behavior of such gas wells can be predicted without having to revert to long time flow tests. The method consists of using the isochronal test procedure to establish the slope of the back pressure curve, "n", and the short time variation of the performance coefficient, "C", with time.

Equilibrium Calculations on the Kelly-Snyder Reservoir. H. T. Kennedy, S. G. Dardaganian and J. L. Clanton. *J. Petrol. Tech. 11,* (T.N. 2042) 92 (1959) Sept. (3 pp.)

Article presents equilibrium ratios measured on oil and gas samples taken from the Kelly-Snyder field at the reservoir temperature of 128° F. From these data smoothed curves were constructed for the reservoir fluid up to the bubble-point, 1874 psia. A material balance calculation, based on the use of equilibrium ratios instead of the usual solubility and shrinkage measurements, is made on the field and compared to the conventional method.

Hugoton Field Deliverability Project. F. A. Langenfeld. *Gas 35,* 145 (1959) Oct. (6 pp.)

Data processing center at Northern Natural Gas Co., Omaha, Neb., recently prepared a set of tables to be used in solving deliverability problems. Primary purpose of these tables is to assist the Federal Power Commission technical staff, natural gas pipelines and state commissions in forecasting future rates of gas production involving the Kansas and Oklahoma portions of the Hugoton field, or any field operating under a similar proration system. Computer time required to complete this project was four hours to test or debug the program, and 160 hours for actual calculation. Original calculations and tables were afterwards reproduced and bound into book form. The book consists of 1236 pages, with 100 lines/page and 10 printed factors/line. Calculation time required for each factor was approximately one-half second. Reproductions of some of the tables are included.

Method for Predicting the Behavior of Mutually Interfering Gas Reservoirs Adjacent to a Common Aquifer. K. H. Coats, M. R. Tek and D. L. Katz. *J. Petrol. Tech. 11,* (Summary of T.P. 8082) 231A (1959) Sept.

Fluid communication between any number of oil or gas reservoirs adjacent to a common aquifer in mutual interference effects on their production-pressure behavior. The theory, application and interpretation of pressure build-up behavior of oil wells, drawdown tests on oil or gas producing formations and behavior of several storage reservoirs provide ample experimental evidence of mutual interference. Development of pressure-explicit equations, their solution, their application to a specific case history and an over-all evaluation of the developed method through the comparison of predicted and observed field performances were the main objective of the study.

Methods for Determining Water Contents of Oil-Bearing Formations. W. H. Caraway and G. L. Gates. *U.S. Bur. Mines Rep. Invest. 5451* (Washington: U.S. Govt. Print. Off., 1959, $.50.)

Results of an evaluation of several indirect methods of measuring the water content of oil-reservoir rocks are presented. The water content of oil-base cores is considered to be most nearly representative of the water content of the undisturbed petroleum reservoir and therefore, the direct method of measuring the volumes of water in cores cut in oil-base drilling fluid was adopted as a standard for comparison. The indirect methods evaluated included 1) displacement through a semipermeable membrane by air; 2) centrifuge; 3) evaporation; 4) mercury injection; 5) chloride dilution, and 6) electric logs. Approximately 270 samples of cores from petroleum-reservoir rocks were used.

Reservoir Inhomogeneity Assessment and Control. A. Hutchinson, Jr. *Petrol. Eng. 31,* B-19 (1959) Sept. (8 pp.)

Technical advances in the study of reservoir inhomogeneities will lead to better predictions of reservoir performance with fewer failures in injection operations. These advances will also lead to methods by which the adverse effects inherent in an inhomogeneous system can at least be partially overcome. For example, this is the basis for use of a more viscous injection fluid to mitigate stratification effects. As more is learned about what reservoir inhomogeneities exist, injection operations will be better designed.

Secondary Recovery

Addition of LPG and Gas to an Oil. J. G. Roof and N. W. Crawford, Jr. *Petrol. Eng. 31,* B-32 (1959) Sept. (3 pp.)

Injection of LPG and gas into an oil reservoir can, under certain circumstances, lead to rather complicated phase conditions in the reservoir. As a part of an engineering study for a possible secondary recovery project in an Oklahoma field, a laboratory examination has been conducted of the volumetric and phase behavior of oil from that field when propane and methane were added. Proper analysis of the resulting data will permit determination of the most efficient injection program.

Carbon Dioxide Solvent Flooding for Increased Oil Recovery. L. W. Holm. *J. Petrol Tech. 11,* (T. P. 8079) 225 (1959) Sept. (7 pp.)

Laboratory flooding experiments on linear flow systems indicated that high oil displacement, approaching that obtained from completely miscible solvents, can be attained by injecting a small slug of carbon dioxide into a reservoir and driving it with plain or carbonated water. Data are presented which show the results of laboratory work designed to evaluate this oil recovery process, particularly at reservoir temperatures above 100° F and in the pressure range of 600-2600 psi. Under these conditions, CO_2 exists as a dense single-phase fluid.

Some Criteria in the *In Situ* Combustion of Crude Oil. P. Cooperman. *J. Appl. Physics 30,* 1376 (1959) Sept. (4 pp.)

Crude oil usually has an extremely steep viscosity-temperature characteristic; hence, the application of heat should lower the viscosity considerably. It turns out, however, that the thermal conductivity of rock and fluids is so low that localized application of heat would do little good in a reasonable period of time. Furthermore, the cost of heating 10^5 cu ft or more of rock may be higher than can be justified economically. From this it follows that if heat is to be used cost of the heat must be low. The process known as *in situ* combustion satisfies both of these requirements. Essentially it consists of generating a combustion zone at a well by local heating and then moving it out into the reservoir. The fuel used is the crude oil itself and of course, air or oxygen must be supplied. For this reason, it is necessary that one be able to pass air from one well into another located some distance away before the oil has been displaced from the porous medium, but this is possible. Physically, the air flow has two functions: 1) It tends to force the oil out of the pores and 2) it feeds the combustion zone which, by heating the oil ahead of it, makes the displacement easier.

In Water Flooding: Use these Graphical Methods to Determine . . . When Radioactive Water Tracers Reach Well, What Tracer Concentrations to Use. G. E. Vaughn, Jr. and J. W. Watkins. *Oil Gas J. 57,* 189 (1959) Sept. 7 (6 pp.)

Method described can be extended for use with any flooding pattern for which the pressure distribution can be determined. In respect to tracer dilution or loss, only mechanical or physical dilution is considered, with any effect of diffusion, adsorption, ion exchange, or other probable causes of tracer loss or dilution ignored for purposes of this article. To simplify calculations from available data, the problems involved in predicting arrival times and concentration of tracer in the produced fluids can be approached most conveniently under assumed homogeneous conditions of the reservoir and subsurface fluids. Then, the concentration of tracer in the produced fluids will depend on: 1) The extent of dilution with barren fluid at the producing well; 2) the volume of tracer-bearing slug and 3) the input tracer concentration.

Well Practice

Hydraulic Perforating. *Petrol. Eng. 31,* B-88 (1959) Sept. (4 pp.)

Hydraulic perforating is a process of pumping a fluid and an abrasive to erode a hole through the pipe, cement and into the formation. The new service, now being offered by two service companies, is fast being found as a quick, effective and economical method to: Enlarge well bore diameters; remove scale or other deposits from the faces of producing formations, and perforate casing without the use of explosives. The erosion of sand on metal is well-known to the petroleum industry. For the past several years attempts have been made to harness this force and put it to a practical use. Hydraulic perforating has resulted.

Secondary Recovery

Method of and Means in Heating of Sub-Surface Fuel-Containing Deposits "In Situ". G. J. W. Salomonsson and B. Persson (assigned one-half to Svenska Skifferolie Akt, and one-half to Husky Oil Co.) U.S. 2,902,270 (1959) Sept. 1.

In the recovery of fluid fuel products from underground stratified deposits by heating the deposit *in situ*, improved heating over the whole thickness of strata is claimed for a novel gas burner. This burner comprises three concentric tubes of a length reaching from surface to bottom of deposit. The smallest inner tube conveys gas, and the next largest conveys air to a designated and adjustable depth to form a gas burner at the open tube bottoms. The third outer tube with closed bottom acts as a vent or chimney to return the hot gases upward through the fuel strata and to the surface, the tube walls conducting and spreading the heat of the flame over a great vertical interval of the outer tube wall to uniformly heat the deposit and drive its volatile components to a collecting well.

4. GAS CONDITIONING AND LPG RECOVERY

Dust Removal

Ultra-sonic Dust Precipitation. E. Zedet. *Gas J. 299*, 242 (1959) Sept. 9 (3 pp.)

Descriptions of experiments conducted in France on an industrial scale. Effectiveness of ultrasonic dust precipitation or its industrial economy cannot as yet be guaranteed. Results realized with tars do not permit extrapolation of results obtained with other dusts of other chemical compositions. The first whistle experimented with consumed 180 m^3 of air at 3 kg/sq cm to treat 500m^3 of products of combustion per hour with an efficiency of 93.4% but a sonic efficiency of 3-5%, with a power consumption of .05 kWh/m^3. To treat 100,000 m^3 would require, with the test generator, 200 units each of 180 m^3/hr compressed air corresponding to a power consumption of 1800 kWh with cost of the order of 129,000 francs. Substitution of the new generator should reduce the cost of power to around 5000 francs. The total cost of treatment including capital charges should be definitely lower than with electrostatic apparatus. It is not, however, advisable to visualize a competition between the two techniques —they should work together.

Gas Conditioning

Bibliography on Gas Conditioning—1958 Supplement. L. M. van der Pyl. Paper CEP-59-10. New York: American Gas Association, 1959, $.25.

Bibliography covers available information on papers and patents relating to gas conditioning for the year 1958. It is a continuation of the bibliographies prepared and published by previous A.G.A. Subcommittees on Gas Conditioning of the Chemical and Engineering Committee. Current listing cites 436 items.

Survey of Current Gas Conditioning Practices. H. Laudani. Paper CEP-59-7. New York: American Gas Association, 1959, $.25.

Current emphasis on problems of gas conditioning is on the effects of dry natural gas. In an attempt to ascertain the current practices of the industry relative to the gas conditioning problems facing it and methods employed for mitigating these problems, a questionnaire was prepared by the Subcommittee on Gas Conditioning of the Chemical and Engineering Committee. This questionnaire covered the subjects of oil fogging, humidification, frost difficulties, determination and removal of suspensoids and internal sealing of mains. Report summarizes the information submitted in the gas conditioning section of the questionnaire to aid in evaluating the effectiveness of various gas conditioning methods presently employed.

Gasoline Recovery

Development and Evaluation of Gas-Condensate Reservoirs. Part 5. Design and Application of Gasoline Plants. W. C. Goodson. *Petrol. Eng. 31*, B-76 (1959) Sept. (3 pp.)

From a managerial standpoint, four possibilities exist at the time a gas purchase contract with suitable processing agreement is negotiated: 1) Construction and operation of the gasoline plant by the producing company or companies; 2) construction of the plant by an outside interest; 3) process the gas stream in an existing gasoline plant for return of a portion of the products to the producing company, and 4) in the event none of the first three can be negotiated, the producing company forfeits all rights to future claims on the recovered liquids. Advantages and disadvantages of each of the alternatives are discussed.

Hydrogen Sulfide Removal

Bibliography of Processes for Removing Hydrogen Sulfide from Industrial Gases. January 1950 — December 1957. S. Katell and L-T. Fan. *U.S. Bur. Mines Info. Circ. 7886.* (Washington: U.S. Govt. Print. Off., 1959, $.30.)

Processes using synthesis gas from coal for producing liquid and gaseous fuels are being developed by

the Bureau of Mines. Removal of sulfur compounds from the gas is an integral part of the program; consequently the literature has been searched. Report is a compilation of references, with abstracts of the information dealing with one phase of the subject. It is concerned with removal of hydrogen sulfide gas from a gas stream and covers the literature published during the period designated in the title.

Dust Removal

Method for the Elimination of Finely Divided Carbonaceous Material from Gas Streams. E. J. Houdry and C. T. Hayes (assigned to Oxy-Catalyst, Inc.) U.S. 2,905,523 (1959) Sept. 22.

In a gas stream containing carbonaceous solids and combustible gases, but in concentrations below flammability, the invention claims steps of catalytic oxidation of gases to raise the temperature to 1200°-1600° F, further oxidation, and then heating in the presence of ceramic surfaces to 1800°-2200° F to completely burn the dust.

5. NATURAL GAS TRANSMISSION

Automation

Before You Go All Out for Computer Control for Your Pipeline: Pause and Ponder . . . J. T. Manry III. *Oil Gas J. 57,* 172 (1959) Oct. 5 (3 pp.)

Planning the steps to a given control level in phases may be proper method in determining which level of control is best for a given pipeline. Author says that getting into remote control gradually and testing telemetering, communications, and supervisory-control equipment provide the setting for more and more help from the computer. Company experience in using electronic computers should certainly be useful in the transition period before any all out system computer control plan is adopted.

Compression

Determine Compressibility Factors by Using the Burnett Method. I. H. Silberberg, K. A. Kobe and J. J. McKetta. *Ind. Eng. Chem. 51,* 1325 (1959) Oct.

With only measurements of pressure and temperature, the Burnett method may be utilized to obtain precise PVT data. Compressibility factors are determined from experimental data by analytical or graphical means.

Studies of Jet Compression—1. Apparatus and Methods. Results with Air at Room Temperature. H. J. Hoge, S. S. Eichacker and D. L. Fiske. *J. Basic Eng. 81,* 426 (1959) Sept. (7 pp.)

Experimental jet compressor (ejector) employing gases as subatmospheric pressures is described and data are presented showing efficiencies obtained with air used as both the driving and the driven fluid. A technique is described by means of which efficiency may be determined as a function of outlet pressure and entrainment ratio. Curves are presented showing that efficiency passes through a maximum as outlet pressure is increased. The compression ratio of the driven fluid likewise passes through a maximum as the outlet pressure is increased, but the maximum of efficiency occurs at a slightly higher pressure than the maximum of compression ratio. The highest efficiency achieved was 20.6%, at an entrainment ratio of 1.3 and a compression ratio of 1.14. The ratio of pressure of driven steam to pressure of driving stream at time of contact has been determined. The value of this pressure ratio corresponding to maximum efficiency was found to increase linearly with entrainment ratio over most of the range of the measurements.

Compressors

Why Recip Compressors Act as They Do. C. S. Kenworthy. *Oil Gas J. 57,* 201 (1959) Sept. 21 (3 pp.)

Some of the questions which trouble people concerned with the operation of gas lines are: Why does compressor horsepower requirement increase to a maximum and then decrease as suction pressure is progressively lowered; as discharge pressure is progressively increased, why does compressor horsepower requirement increase to a maximum and then decrease; how do volume unloaders allow the operator to keep a compressor running at maximum efficiency; why does lowering line pressure below design result in less efficient compressor operation. These are answered after logical step-by-step development of the various concepts encountered in the compression cycle. Answers are given simply, in terms of simple diagrams, rather than complicated mathematical equations.

Compressor Stations

How to Solve the Dust Storm Problem. D. M. Taylor. *Pipe Line Ind. 11,* 49 (1959) Sept. (4 pp.)

Northern Natural Gas Co.'s Liberal, Kans. station, a small one, has four 26 x 36 twin tandem horizontal engines of 1600 hp each. Typical of stations built in 1950, the building has asbestos sheet sides, a large expanse of glass and windows, gravity roof ventilators and large access doors at each corner and in the middle of each side. Once the sealing compound had been selected, the caulking was contracted, and weather stripping was added to doors and other openings. Calculated volume of the build-

ing was 236,000 cu ft. Engineers estimated that if an air supply system could supply an air change every three minutes—or about 75,000 cfm—it would maintain a positive pressure of 0.90 in. of water inside the building with normal leakage that could be expected around doors and windows.

Engines

Aluminum Bearing Experiences. J. B. Eaton, Jr. Paper GSTS-59-17. New York: American Gas Association, 1959, $.25; *Gas Age 124,* 43 (1959) Sept. 17 (2 pp.)

Texas Gas Transmission Corp. has been using aluminum bearings since February, 1953, and now has in service a total of 622 aluminum bearings in 56 engines which by the end of 1958 had accumulated over 1,300,000 engine hours. In an area where 273 failures with original bearings were experienced over a 1,414,000-engine hour span, failures number 87 over 1,323,000 hours.

Vapor Phase Cooling and Low Pressure Steam Utilization. C. D. Long and H. W. Egger. Paper GSTS-59-14. New York: American Gas Association, 1959, $.25.

Ever-increasing demand by the public and gas utility management to deliver reliable natural gas service to the consumer at reduced cost has brought many innovations to the compression phase of gas pipeline transmission. Some of these have been aimed at higher thermal efficiency of the prime mover; others at increased operated horsepower per manhour of labor to effect lower payroll costs. Few, however, have taken dead aim at both and resulted in accomplishment of those aims plus reduced engine maintenance costs. Paper outlines story of vapor phase cooling and low pressure steam utilization as employed at the Cabeza Creek Station of United Gas Pipe Line Co.

What Happens to Engines in the First 100 Hours? E. J. Fithian. *Pipe Line Ind. 11,* 53 (1959) Sept. (3 pp.)

To find the answers that would effectively help evaluate engine wear and oil consumption, particularly during the break-in period, research engineers of the Cooper-Bessemer Corp. in conjunction with Battelle Memorial Institute have developed a radioactive tracer method of engine research. Method has proved to provide the necessary sensitivity in that it successfully measures the rate of oil consumption as a function of time and engine operating conditions.

Metering

Metering Equipment. R. D. O'Neil. *Gas Age 124,* 45 (1959) Oct. 1.

Metering stations (on the Florida pipeline) are of several different types depending on capacity and application: 1) Dual meter runs; 2) multiple meter runs; 3) dual meter run, combination and 4) single meter run, positive displacement. Equipment for each type is described.

Orifice Metering Equipment. W. A. Griffin. *Gas Age 124,* 51 (1959) Oct. 1 (2 pp.)

All of the Houston Corp.'s sales stations employing orifice measurement were designed using the three-piece master tubes with a Daniel Senior type orifice fitting as the primary device. This tube consists of the inlet section and the downstream section. The second basic type, the Daniel Junior Orifice Fitting, was developed for use where two or more meter tubes are joined by a common header. This fitting is a single chamber unit. The third type, the Simplex Orifice Plate Holder, was used in sizes 2- through 6-in. and in pressure ranges through 600 lb ASA.

Pipeline Construction

Deep Water—Pipeliner's Dream?—Don't Sell It Short. *Pipe Line News 31,* 28 (1959) Sept. (3 pp.)

Brief analysis compares certain aspects involved in the construction of land and of offshore pipelines to determine what advantages or economies are inherent to each. Three general classes of pipelines are considered: 1) Normal land pipelines; 2) shallow water offshore pipelines, and 3) deep water offshore pipelines. Break between shallow and deep water is the depth at which bottom water motion, during storm conditions, becomes so small that burying or anchoring the line is not required. Deep water line is considered to traverse a maximum depth of about 400-600 ft. Article considers some of the factors contributing to the cost of pipelines to determine what really apparent savings or advantages accrue to each of the three classes of pipelines.

The Design and Installation of Pipeline River Crossings. L. M. Odom. Paper GSTS-59-16. New York: American Gas Association, 1959, $.25.

Subject encompasses a field in which not nearly all of the answers are known. New developments are continually taking the place of former practices. However, these developments are largely in methods of construction and materials. Insofar as site selection and design are concerned, the only innovation which would provide any real improvement would consist in having available a great many more gauge records, more annual hydrographic surveys and more data regarding soils and geology of particular rivers. Until a great deal more of such information does become available, the degree to which the primary objective of obtaining a long-lived pipeline river crossing for the least possible cost is realized

will continue to depend to a large extent upon the ability of the designer to choose the right factors of safety.

Mexican Pipeliners Fight Swamps, Rivers, Mountains. M. S. Albans. *Petrol. Eng. 31,* D-19 (1959) Sept. (3 pp.)

From water-logged Tabasco in isolated southern Mexico to 7500 ft-high Mexico City, Petroleos Mexicanos is constructing its longest and most difficult pipeline. This 500-mile 24-in. industrial gas line fords hundreds of kilometers of swamps, lagoons and rivers, twists through 90% rock, bucks up to 40% grade, and climbs 9000 ft above sea level. By the middle of 1960, 220,000,000 CF/day of gas from Pemex City's new absorption plant will be divided between the Valley of Mexico's swift expanding industrial section and towns along the route. Two compressor stations to be built later will increase the flow considerably.

Natural Gas: Measurement and Dispatching in Florida. W. F. Kienast. *Gas Age 124,* 33 (1959) Oct. 1 (6 pp.)

Fast pace was required to form an organization of over 1000 personnel and complete the following construction between October, 1958, and June 1, 1959: 1) Connect 60-odd producers; 2) lay 2654 miles of transmission system; 3) construct eight compressor stations; 4) connect 70-odd sales stations, and 5) convert some 65,000 customers from manufactured to natural gas. This was accomplished through an organization with three measurement superintendents: One in Houston, Texas, responsible for production; two in St. Petersburg, Fla., responsible for transmission sales and for distribution. One dispatching superintendent also is located in St. Petersburg. Overall three are approximately 70 personnel in the measurement and dispatching department with 12 others working part time on these functions.

Rocket Power . . . A New Pipeline Tool. J. Joseph. *Gas 35,* 151 (1959) Oct. (3 pp.)

For emergency welding, either in air or water, pipeline constructors soon will have a rocket-fueled welding torch, a simple device capable of attaining temperatures to 4000° F. Prime applications: For low-cost emergency welding, as in pipelines, water tanks or where conventional welding machines are not available. Probable cost: Less than a dollar per torch. Designed and already available are prime mover rockets which can unmire construction equipment, roll heavily laden rail cars to unloading spots and inch cumbersome beams into place. In the design stage—the first short-haul freight lobbing rocket. This projectile, with range up to about five miles, is destined to supply hard-to-reach pipeline construction sites with small tools and equipment. In the rocket works are propulsion brakes—designed as emergency equipment for trucks and heavy machinery working dangerous grades. Already developed is a rocket-fueled "wand" that hurls a malt-thick borate some 40 ft to extinguish construction-site fires. Nearing production is a line-heaving Very pistol that fires a 1½-in. diam, 6-in. long rocket to which is attached a pilot line. Once the pilot reaches its target, heavier lines (tied to the pilot) can be hauled in. Most spectacular contribution to pipeline construction is Aeropak—"rocket wings" that can boost a welder atop a pipe bridge, lift a surveyor across a block-wide river or over a rocky mile of terrain in just under a minute.

Transco Crosses Hudson River with Dual Lines. *Petrol. Eng. 31,* D-22 (1959) Sept. (2 pp.)

For the third time, Transcontinental Gas Pipe Line Corp. has linked its 1840-mile system with the New York metropolitan area to bring increased gas supplies to consumers. The crossing was made at 72nd St. where maximum depth is 50 ft below mean low tide; the river bottom is of hard mud with no rock. The current is swift, but this will not affect operations as the pipe was laid in a trench 20 ft wide and 25 ft deep, placing it 75 ft below mean low water level. Additionally, the pipe was covered by "select" backfill consisting mostly of sand. The fill amounted to 250,000 cu yd.

Pipeline Operations

Internal Cleaning Operations on Pipelines. Part 1. The Water and Detergent Method. C. McClure. Paper GSTS-59-13. New York: American Gas Association, 1959, $.25.

Method selected for keeping the pipe wall smooth varies with: 1) Pipeline load factor; 2) frequency of contamination; 3) deliverability of the pipeline; 4) length of the pipeline and 5) compressor horsepower available. If water is available and suitable, the line is available for cleaning for 15 hours or more and infrequent cleaning is necessary, the water and detergent method should be used. Preparations, instruments, procedure, results, costs and equipment developments are presented.

Internal Cleaning Operations on Pipelines. Part 2. On-Stream Method. P. L. Hughen. Paper GSTS-59-13. New York: American Gas Association, 1959, $.25.

Program of on-stream cleaning to maintain high line efficiencies can be designed from the information accumulated on each line section through periodic efficiency studies and historical records of scraper runs required to bring line efficiency up to the ex-

pected level. The cost of such a program can be estimated by using the average cost per scraper run mile and historical records of number of scrapers required in each section to reach and maintain expected level. Procedure designed to fully utilize personnel by running pairs or trains of scrapers and to utilize full life of scraper brushes and rubbers will save money. Prime advantages of on-stream cleaning are: No loss of service, no appreciable gas loss, no additional personnel requirements, no temporary facilities required, and all facilities used are capitalized.

Internal Cleaning Operations on Pipe Lines. Part 3. Off Stream Method. J. N. White. Paper GSTS-59-13. New York: American Gas Association, 1959, $.25.

Method of cleaning pipelines by removing from service and running brush type cleaners through the line is described. Preliminary evaluation and planning with various factors to be considered is given. Desired results may not be obtained if adequate consideration is not given to the effect of cleaner runs as they are made. A graph and other data indicates the effect of cleaner runs as related to increased line efficiency, as well as cost per mile to do this work.

Pipeliners Report on Maintenance. P. Reed and G. Kinney. *Oil Gas J. 57,* 124 (1959) Sept. 21 (15 pp.)

Special report based on industry-wide survey is divided into three sections: Pumping and compressor stations; pipelines and storage tanks. In regard to compressor stations, most natural gas pipeline companies indicate that station is overhauled at regular intervals. Length of interval is determined by various factors. Nondestructive testing is practiced by 90% of the natural gas lines, magna flux being the leading method followed by X-ray, dye-penetration inspection, ultrasonics, and visual inspection by chalk and alcohol. Temperature method of taking centrifugal compressor efficiency has been tried experimentally to some extent. In pipeline maintenance, internal coating is the fastest-developing trend in the industry. A year ago the gas line which practiced internal coating was a notable exception; this year, 40% of the gas lines are coating substantial mileage of pipe internally.

What Research Discovered about Pressure Surges. R. D. Kersten. *Pipe Line Ind. 11,* 66 (1959) Sept. (3 pp.)

When undesirable pressure surge conditions are found to exist in a pumping system, the pipeline engineer may find a solution by dividing the pipeline system into two parts: The pump which generates the pressure fluctuations and the piping system which responds to the pump excitation. Design requirements of corrective devices are partially dictated by practical considerations of pipeline operations. These are: 1) Device should filter over a broad range of frequencies; 2) device should offer a minimum of interference to the mean flow; 3) any number of combinations of the components described could be used, and 4) special attention should be given to components that involve a minimum of moving parts to keep maintenance at a minimum.

Pipeline Systems

Constructing, Testing and Operating a Canadian Natural Gas Pipe Line System. E. V. Hunt. Paper GSTS-59-8. New York: American Gas Association, 1959, $.25.

Author discusses the Alberta Gas Trunk Line Co.'s system and divides his paper into seven sections: 1) Purpose and function of the company; 2) the system; 3) gas supply and control; 4) design considerations; 5) construction; 6) operations, and 7) summary.

Pressure Regulation

Pressure Regulation. G. W. Vincent. *Gas Age 124,* 39 (1959) Oct. 1 (5 pp.)

One of Fisher Governor Co.'s contributions to controlling gas pressures (on the Florida pipeline) was the development of a high-pressure reducing valve and a house service regulator. The pressure reducing regulator used by Houston as the final or second stage cut on all stations, regardless of size, is the Fisher type DiaGrid. This unit offers many advantages both from a performance and maintenance standpoint. The function of the second or final stage reducer is to cut the 250 psig intermediate station pressure to an even, stable 100 psig.

Radioactivity Applications

How to Determine Gas Flow Rate with a Radioactive Tracer. R. T. Ellington, W. R. Staats and D. V. Kniebes. *Pipe Line Ind. 11,* 24 (1959) Oct. (7 pp.)

Short half-life inert atom—Argon 41—is proving highly satisfactory, tests indicate, as a new tool for determining gas flow rates where orifice meters are not available and where the ammonia tracer technique cannot be used. Techniques, equipment for injection, tracer preparation, transportation, and detection have been developed through a research program sponsored by the Pipeline Research Committee of the American Gas Association. Important advances have been made in this area by analyzing the effect of flow distance, pipe diameter and flow rates on tracer dispersion.

Telemetering

Telemetering Facilities. R. C. Gillette. *Gas Age 124,* 43 (1959) Oct. 1 (2 pp.)

Pressures and differential pressures are measured at the various metering stations (on the Florida pipeline) with telemeter transmitters, and the information is sequentially transferred to intermediate multiplex transmitters, then transmitted to the St. Petersburg dispatch center. At St. Petersburg, multiplex receivers separate the information and transfer it to the proper telemeter receiver.

Telemetering, Remote Control and Automatic Calculation. C. E. Pettry. Paper GSTS-59-2. New York: American Gas Association, 1959, $.25.

Progress report on the telemetering, remote control and data processing system installed by the Charleston Group Companies of the Columbia Gas System, Inc., after the system had been in operation for more than a year. It is concluded that such a system is both operationally and economically feasible.

Metering

Gas Flow Measuring Equipment. H. Gehre. U.S. 2,900,819 (1959) Aug. 25.

Gas flowing through a pipeline has a meter volume correction applied by maintaining a constant volume of comparison gas at the same temperature and continuously measuring the change in pressure differential between comparison gas and pipeline gas as a volume reduction factor.

6. GAS AND LPG STORAGE

Gas Holders

New Waterless Gas Holder Sealants, Their Selection and Use. J. A. Knell. Paper CEP-59-4. New York: American Gas Association, 1959, $.25.

Koppers Co. in conjunction with Gulf Oil Corp. has completed considerable research with petroleum products in search of an oil that would be suitable for use as a sealant. Two stock products, designated as No. 564 Oil and No. 565 Oil, indicate characteristics that make them superior to any sealant that has been used. Since 1955, twelve waterless gas holders, representing a total capacity of 101,000,000 CF, have been converted for the use of No. 564 or No. 565 Oil as a sealant. Results obtained in waterless gas holders with the use of oil as a sealant eliminates all problems that existed with car sealant.

LPG Storage

LPG Underground Storage Capacity Jumps 15%. R. B. Bizal. *Oil Gas J. 57,* 75 (1959) Sept. 28 (4 pp.)

Industry is busy developing more underground storage space to take care of the fast-growing LPG market. Capacity in the U.S. has climbed to 49,024,000 bbl, counting the projects which are currently under way and scheduled for completion within a year. This is an increase of 15% over last year and three times greater than the 1955 capacity. Article indicates that 22 states in the U.S. now have LPG storage facilities. Table indicates company, type of storage, capacity and product for U.S. and Canadian underground LPG storage facilities.

Methane Liquefaction

How LNG Aluminum Tanks Were Welded. H. W. Bailey. *Gas Age 124,* 34 (1959) Sept. 17 (2 pp.)

Five tanks constructed for the "Methane Pioneer" had to meet rigid requirements involving containing liquefied natural gas at −258° F. The tanks were constructed of 5356 aluminum alloy and measured 40- by 30- by 28-ft. All joints were made with inert gas shielded-arc processes and required approximately 50,000 ft of welds. Tanks were then insulated with 12 ft of laminated balsa supported on surrounding steel jackets. Machines, operating at a rate of 12 in./min, made approximately 40,000 ft of fillet welds. Mechanized welding equipment, working a 18 in./min, completed the remaining 10,000 ft of welds using a newly developed square-butt technique for welding heavy aluminum.

Storage of Liquefied Petroleum Gases in Prestressed Concrete Pipe. R. J. Sweitzer. Paper CEP-59-15. New York: American Gas Association, 1959, $.25; **Pre-Stressed Concrete Pipe Proves Practical for LPG Storage.** *Amer. Gas J. 186,* 21 (1959) Sept. (4 pp.)

Prestressed concrete embedded cylinder pipe has been successfully used for both oil transmission lines and LPG storage. It is greatly superior to ordinary concrete pipe because of the "built-in stresses" which permit the steel and concrete to act as an elastic structure. It is a quality product, carefully tested. It is fireproof and maintenance-free. Since it is below ground, it cannot be damaged by mobile equipment, and zoning problems are minimized. Innumerable layouts can be executed depending only upon available space and the designer's imagination. It is economical in large installations.

Underground Storage

The Storage of Gas in Water Sands. D. Ball and P. G. Burnett. Paper GSTS-59-9. New York: American Gas Association, 1959, $.25.

Ten water-sand storages are helping (or are about to help) maintain low gas bills today. These are: Herscher, serving Chicago; Lange and Waterloo,

serving St. Louis; Doe Run, serving Louisville (Ky.); Madison, serving the Montana Power Co. System; Redfield, serving the northern end of the Northern Natural System; Brandywine, about to serve Washington, D.C.; Troy Grove, serving the distribution area of Northern Illinois Gas Co.; Waverly, subject to intense experimentation for use by the Panhandle Eastern System, and Beynes serving Paris. In addition, Vernon is testing to serve Paris and in Germany, water-sand storages are located in Hamburg and Hanover. Authors discuss requisites of underground storage, sedimentary rocks and how they provide storage, other criteria, mechanics and design.

Techniques Employed for the Study and the Realization of Underground Gas Storage Facilities in Aquifer Reservoirs. E. Clarac, R. Monicard and L. Richard. Section VIII-Paper 9. New York: Fifth World Petroleum Congress, 1959.

Underground storage of gas, which is being practiced on a large scale in the U.S. and other countries, is now being used in France. Currently, two different types of storage have been put in operation. One of them, situated at Beynes, near Paris, has been developed by Gaz de France; the other, situated at Lussagnet, has been developed by the Societe Nationale des Petroles d'Aquitaine, near the oil field of Lacq. Gas de France also is studying the structure at Vernon, near Paris, which offers favorable conditions for underground storage. Unconsolidated aquifer sands were chosen for these three types of storage. Storing gas in such reservoirs is a much more complex venture than storing it in old depleted stratas, which are non-existent in France. Paper describes the studies, techniques, tests and the derived estimated potential flow rates of the wells.

Volume Variations of Underground Storage Reservoirs. H. D. Yoo, D. L. Katz, R. R. White and M. R. Tek. *Petrol. Eng. 31*, B-27 (1959) Sept. (5 pp.)

Large number of gas producing sands eventually converted to gas storage use occur with fluid communication with a large water-bearing formation, or aquifer, surrounding or underlying the gas reservoir. As the pressure in the gas bubble adjacent to the aquifer changes by a cyclic variation due to seasonal injection and withdrawal of the natural gas, the motion of the aquifer-gas interface causes the net volume available for gas storage to fluctuate. Consequently, the pressure-volume behavior of the gas reservoir subjected to water drive is, in general, governed by the average pressure within the gas reservoir, compressibility of the gas and expansibility of the aquifer fluid, and the physical properties of both the gas-bearing sand and the surrounding aquifer formation. A theoretical prediction of the water movement in and out of the gas storage reservoir and an empirical method to correlate the current net storage volume to reservoir pressure-production data have been the main objectives of the study reported.

Methane Liquefaction

Method and Apparatus for Unloading Cold Low Temperature Boiling Liquids from Storage Reservoir. S. Beckwith (assigned to Constock Liquid Methane Corp.) U.S. 2,897,658 (1959) Aug. 4.

In transportation of liquefied methane at ambient temperatures and atmospheric pressures, an improved tank loading method is claimed. It comprises connecting the liquid and vapor discharge lines to receiving (shore) mains and storage, shutting off the escape of vaporized methane to build up pressure on the liquid in the transport tank (or multiple tanks) whereby liquid methane is forced out through a dip tube from the tank bottom and into the shore main and storage. Heat transfer to ship tanks may be increased by warm gas or liquid coils.

Method of Liquefying Natural Gas. W. L. Morrison (assigned to Constock Liquid Methane Corp.) U.S. 2,900,796 (1959) Aug. 25.

This invention provides means for controlling the concentration of nitrogen, other non-condensibles and inerts, in a liquefying system for natural gas wherein the gas circulates in a closed system, expands and does external work with resultant cooling and liquefaction of a part of the gas and recirculation of the uncondensed portions. Another objective is to continuously withdraw from such a system, after expansion of the gas and withdrawal from the system of the liquefied portion of the gas, such quantity of nitrogen and non-condensibles and inerts as will at least compensate for the amount brought into the system by the raw gas for liquefaction.

Underground Storage

Underground Storage of Ammonia and Its Recovery. L. W. Adams and J. E. Cottle (assigned to Phillips Petroleum Co.) U.S. 2,901,403 (1959) Aug. 25.

Liquid ammonia is stored in an underground salt cavity after purging air from the cavity by off-gas from the ammonia plant. In recovery the off-gas is pressurized to lift the liquid ammonia to a tank to be depressurized, water is added and the solution is distilled to recover gaseous ammonia and remove dissolved salt as still waste.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Coal Carbonization

Process for Making Ethylene and Aromatics by Carbonization of Lignite. R. S. Montgomery, D. L. Decker and J. C. Mackey. *Ind. Eng. Chem. 51*, 1293 (1959) Oct. (4 pp.)

Both ethylene and aromatics such as benzene can be made by the low-temperature carbonization of lignite followed by a high-temperature cracking of the tar vapors without intermediate condensation. Texas lignite was found much superior to North Dakota lignite in this process and good results were obtained with a carbonization temperature not exceeding 550° C and a cracking temperature of about 800° C. Process could be of commercial importance when the cost of crude oil increases to an extent that would offset this process's higher initial capital cost.

Coal Gasification

Manufacture of Substitute Natural Gas from Coal. C. G. von Fredersdorff and F. E. Vandaveer. Paper CEP-59-8. New York: American Gas Association, 1959, $.25.

Three basic methods for production of high-methane-content gases from coal are: 1) Pyrolysis; 2) hydrogenation, and 3) gasification-methane. Advantages and disadvantages of each method are outlined. Third method, a dual-step process, is discussed in detail. European and American developments in the production of synthesis gas (H_2-CO) mixture, first step in the process, are outlined. Experimental developments in methanation and hydrogenation are presented. Possibility of using atomic energy as a source of heat for gasification reactions is considered.

New Developments in Anthracite Gasification. J. W. Eckerd and J. Ratway. Paper CEP-59-6. New York: American Gas Association, 1959, $.25.

Description of recent research conducted by the U.S. Bureau of Mines on the gasification of anthracite. Paper summarizes data obtained using high-pressure Lurgi-type generators of 4-, 6- and 13.5-in. ID, and presents detailed data of tests conducted in a commercial size modern Lurgi plant in Dorsten, Germany. Description of the plant and the operation procedures are included. Gasification rates, steam-oxygen ratios, and steam and oxygen consumption for two sizes of Pennsylvania anthracite containing 27 and 19% ash, respectively, are shown.

The Peak Load Problem in Gas Production. H. Weittenhiller. *Gas- u. Wasserfach 100*, 839 (1959) Aug. 14 (8 pp. German text.)

Peak load problem, present throughout the development of the gas distribution industry, is reviewed. The growth of the Ruhr grid demand indicated the need for extremely large volumes of coal gas to supply peak demands by addition to the normal grid supply of mixed coke oven and water gas. An oxygen pressure gasification plant was built at Dorsten as a major new effort less costly than coke ovens, and designed as a multi-generator or standby plant to attain the flexibility in output needed for peaks. Improved operating cycles with reduced steam blast have permitted generator outputs to vary between 150,000-400,000 m^3/day. Additional flexibility is attained by reforming of the generator gas and natural gas by using air in the generator, or by altering proportions of these gases in finished gas. These operations must proceed while holding the standard of 4300 kcal/m^3 in heating value. Thus the plant with spare generators can meet a daily demand varying from 750-1,900,000 m^3/day. Limitations in oxygen and coal supply and purifier capacity are discussed.

Ethylene

A Computer Study of a Free-Radical Mechanism of Ethylene Pyrolysis. R. H. Snow, R. E. Peck and C. G. von Fredersdorff. *A.I.Ch.E. J. 5*, 304 (1959) Sept. (6 pp.)

Pyrolysis of ethane (including the equilibrium behavior and the tendency to form secondary products) has been reproduced by calculations based on a reaction mechanism which includes the reverse of the chain propagating reactions as well as other hitherto neglected elementary reactions. Reverse reactions are important even at low conversion (1%); hence previous investigations of initial reaction rate have doubtful fundamental significance. Values of rate constants used in the calculations were taken mostly from the literature. Consideration was limited to reactions of methyl, ethyl, and hydrogen-free radicals with ethane and its primary pyrolysis products. The results can be incorporated into reactor performance calculations to replace empirical reaction rate correlations and thus widen the range of conditions over which the calculations are reliable.

Hydrogen

Need Hydrogen? Examine This Process. N. C. Updegraff. *Petrol. Refiner 38*, 175 (1959) Sept. (4 pp.)

Hydrogen required by American Gilsonite is produced by steam-hydrocarbon process. Plant has a capacity of approximately 600,000 CF/day of 92% hydrogen. The normal feedstock is a refinery stream consisting largely of propane and butane. The plant also is designed to use various alternate feedstocks

for startup. It has been in operation since May, 1957.

Petrochemicals

Petrochemical Raw Materials for Nylon Resins: Part 1. P. W. Sherwood. *World Petrol. 30,* (Ann. Refinery Rev.) 59 (1959) July 15 (3 pp.); **Part 2.** *World Petrol. 30,* 55 (1959) Sept. (4 pp.)

Nylon is the generic name for a group of polyamides employed in the production of synthetic fibers and plastics. Three intermediates constitute the bulk of raw material in nylon production: Adipic acid and hexamethylene diamine for nylon-66 and caprolactam for nylon-6. All three can be and are produced by various routes; in all three, production from petroleum-derived chemicals is rapidly assuming the dominant role. Article discusses economic and supply situation pertaining to these petrochemical nylon intermediates.

Review of Fauser-Montecatini Process for Transforming Petroleum Products into Primary Materials for Chemical Synthesis. A. Righi. *Rivista dei Combustibili 13,* 523 (1959) July-Aug. (14 pp. French text.)

Various Fauser-Montecatini processes for converting petroleum products into raw materials for chemical synthesis include the production of ethylene, acetylene and synthesis gas obtained in processing the original gaseous or liquid hydrocarbons. A description of the technological flow chart and the main operating data are given for these processes.

Review of Recent USA Patents on Oxo. H. Heinemann and H. Shalit. *World Petrol. 30,* 84 (1959) Sept. (4 pp.)

Review deals with the Oxo process for preparing oxygenated compounds from olefins. Briefly, Oxo process consists in reacting olefins with carbon monoxide and hydrogen in the presence of an iron group catalyst, usually a carbonyl of cobalt. In this first stage the principal product is an aldehyde containing one more carbon atom than does the olefin. The aldehyde may then be hydrogenated to the alcohol or oxidized to the corresponding acid; however, before either of these reactions are carried out, it is necessary to remove the cobalt catalyst from the aldehyde product. The process presents several interesting problems allied with preparation of the catalyst, operation of the carbonylation reaction, decobalting the aldehyde product, and subsequent treatment of the products.

Petroleum Refining

American Petroleum Refining. H. S. Bell. (4th ed.; Princeton: D. Van Nostrand Co., Inc., 1959.) 529 pp; $12.50.

In this edition of his well-known book, the author presents concisely the advances of the past decade combined with the older basic practices of the industry. Admirable compactness of the presentation is achieved by plentiful use of data, graphs, statistics, flow sheets, drawings and photographs in descriptions of the various processes and products of refining. The brief economic review of national and international refining in the industry forms an introduction. The raw material then is discussed in three chapters on chemical and physical properties. Broad aspects of the manufacturing process and the location of plant are followed by three chapters of basic description of distillation, heat transfer and fractionation. The development of these three processes into large-scale refining equipment is taken up in further chapters on pipe heaters, condensers, exchangers and stills. Sixty pages in the next three chapters are devoted to cracking . . . theory, and modern and catalytic systems. Final treatment processes such as caustic, hypochlorite, hydrogenation, or other sweetening for gasoline and distillates are briefly discussed, as are the motor fuel specifications and processes—alkylation, isomerization, polymerization and reforming. Treatment of lubricating oil fractions by dewaxing, solvent extraction and clay filtration receive much attention. The final six chapters discuss the current general practices in blending, storage, measurement, evaporation loss, fire protection, plant services and waste disposal. References generally are to older literature, but key modern citations are given. A clear picture of the refining industry is presented—one which is useful for workers in other technical fields.

Plant Wastes

Humble Attacks Pollution at Baytown. Part 1. L. Resen. *Oil Gas J. 57,* 176 (1959) Oct. 5 (6 pp.); **Part 2.** *Ibid.,* 172 (1959) Oct. 12 (4 pp.)

Multipronged attack on air and stream contamination at Humble Oil & Refining Co.'s Baytown, Texas, refinery has resulted in a marked improvement in contamination problems associated with plant-processing operations. All-inclusive program is still a continuing growing project even though more than $6,000,000 has been spent on it during the past decade and the original goals have been surpassed for some time.

Reformed Gas

Performance of Supported Nickel Catalysts in Cyclic Steam Reforming of Natural Gas. J. M. Reid and D. McA. Mason. Paper CEP-59-3. New York: American Gas Association, 1959, $.25

Comparatively little data are available regarding the performance of catalysts in the cyclic steam-

hydrocarbon reforming process used by the utility gas industry on the Eastern seaboard, and more extensively in Europe and Asia. In this study, several commercial types of supported nickel catalysts having either alumina or magnesia as the base material were subjected to cyclic process conditions in a laboratory reforming apparatus. Catalyst performance and catalyst life were significantly affected by the oxygen which was present during the heating portion of the cycle. Unlike the continuous steam-hydrocarbon reforming process used extensively by the chemical industry for production of hydrogen and ammonia synthesis gas, performance of the cyclic process was not found to be singularly dependent on the activity of the catalyst for the steam-hydrocarbon reaction, but rather under certain conditions to be controlled by the rates of oxidation and reduction of the nickel. In these tests, life of alumina-supported catalyst was related to the formation of an unreactive compound between nickel oxide and the support. Life of the magnesia-supported catalyst was related to solid solution formation between nickel oxide and the support. The inadequacy of present manufacturing specifications and testing procedures for nickel catalyst for cyclic reforming is illustrated by these results.

Tar

Delayed Coking of Lignite Tar. M. B. Dell. *Ind. Eng. Chem. 51,* 1297 (1959) Oct. (2 pp.)

In a laboratory study of delayed coking, a topped tar was fed to a heated coke drum at 50 psi. Compared with a petroleum feed, greater amounts of a less-graphitic tougher coke were obtained having a spherical rather than striated pore structure. Liquid products included low boiling phenols from the topping operation and additional quantities from the coker condensate. Work demonstrates how lignite tar may be used as a feed in petroleum processes.

Selected Bibliography on Low-Temperature Tar. H. H. Lowry and H. C. Anderson. *U.S. Bur. Mines Info. Circ. 7882.* (Washington: U.S. Govt. Print. Off., 1959, $.35.)

Abstracts of papers on low-temperature tar published since 1942 are included. Abstracts of paper on low-temperature carbonization are not included unless information is given on composition, economics, processing, or utilization of the tar; thus, papers reporting only yields of tar from assay tests, pilot plants, and commercial operations are excluded.

Carbonization

Treatment at Elevated Temperatures and/or Carbonization of Carbonaceous Materials. W. W. Odell. U.S. 2,898,272 (1959) Aug. 4.

Improved fluidized carbonization process is claimed in which devolatilized coal or char is preheated in a first vessel (heater) by partial combustion with air and steam to obtain a deep fluidized char bed at 1650° F. The char then is separated and simultaneously fed with raw coal to the top of a second vessel (carbonizer) with a coal-char ratio of 70:30. In the second vessel the char imparts heat to carbonize the coal and the whole bed moves downward, non-fluidized, at a rate controlled by bottom discharge of char. Carbonization is completed in the intermediate zone of the second vessel by controlled additions of air, steam and coal gas, and char is cooled by bottom injection of coal gas and steam. Cracked coal gases and volatiles are drawn off at the top of the carbonizer and producer gases are burned for direct heating or process steam raising.

Coal Gasification

Gas Producer with Pulsating Flow. F. Paris (assigned to Institute de Recherches de la Siderurgie.) U.S. 2,899,287 (1959) Aug. 11.

Gas producer with pulsating flow is claimed, in which a periodically-fired fuel and air flame is ejected into a larger refractory reaction chamber where additional fuel (oils, pulverized coal) is injected and raised to reaction temperature, to reduce CO_2 to CO, and H_2O to H_2. Composition of product gas depends on control of air and fuel supply.

Process for Production of Combustible Gases. F. Totzek (assigned to Koppers Co., Inc.) U.S. 2,898,204 (1959) Aug. 4.

Improved yields of synthesis gas from suspended coal dust and oxygen by incomplete combustion are claimed by a two-stage reaction which includes first an axial injection of coal and excess oxygen into a refractory reactor to form an intense combustion zone and CO_2, and simultaneous second axial injection of suspended coal in a deficiency of oxygen, to form an extended reaction zone receiving radiant heat from the first reaction. Both zones are surrounded by a wall-zone of gasifying medium of steam, and extend horizontally to a gas outlet and ash pocket.

Oil Gas

Cyclic Regenerative Process for Catalytic Gasification of Petroleum. H. R. Linden (assigned to Institute of Gas Technology.) U.S. 2,907,647 (1959) Oct. 6.

Cyclic regenerative process is claimed for producing high Btu oil gas in a gas generating set comprising a first and second generator, each connected to a respective regenerator. Each generator contains a bed of cracking catalyst. The system is heated, then hydrocarbon gas and steam enter the first regenerator

for preheating, pass through the first generator for reforming into high hydrogen gas, where the heavy oil is injected in countercurrent flow, to be partly cracked at 1300°-1800° F. Said hydrogen-hydrocarbon mixture is completely cracked in the second generator with steam and withdrawn as 700 Btu/Cf make gas from downstream end of second generator. The cycle reversal repeats the process starting with the second regenerator.

Ore Reduction

Direct Smelting Process in Rotary Kilns. F. Johannsen (assigned to AKG fur Unternehmungen der Eisen- und-Stahlindustrie.) U.S. 2,900,248 (1959) Aug. 18.

In a direct smelting process in an inclined horizontal kiln with solid fuels as reducing agent, improved nodulized products and greater fuel economy are obtained by injecting part of the air blast at a controlled distance from the discharge baffle opening to maintain an excess pressure throughout the kiln.

Iron Oxide Reduction. P. C. Keith and H. N. Woebcke (assigned to Hydrocarbon Research, Inc.) U.S. 2,900,246 (1959) Aug. 18.

Reduction of finely divided iron oxide is carried on by passing pure dry hydrogen through a preheater and then a shallow (1-4 ft) bed at 700°-1000° F and 200-600 psig. The oxide, rendered mobile by the rising gas, flows in zigzag fashion around the vertical baffles across a perforated horizontal plate to an end-outlet where reduced product is discharged. Spent top gases are water-scrubbed under pressure to cool and remove water and CO_2 of reaction, and are recirculated.

Method of Making Sponge Iron. J. Celada (assigned to Fierro Esponja Sa.) U.S. 2,900,247 (1959) Aug. 18.

Reducing gas which may be water gas or reformed natural gas is preheated to 1600° F, mixed with separately preheated air, and then the partly burned mixture is passed downward at 2100° F through a batch of partly reduced granular iron ore. The ore reduction is completed and a secondary off-gas containing high reducing-gas value is recovered and recycled to a second preheating-reducing unit. These reduction operations require a batch time of 4-6 hours, during which time a third reduction unit is being discharged of its reduced ore, and refilled with raw ore. The recharged unit is then connected to the secondary gas stream from the previous unit. The latter then is switched to fresh reducing gas.

Shale Oil

Process for Destructive Distillation of Hydrocarbonaceous Materials. M. W. Putman (assigned to U.S.A. as represented by the Sec. of the Interior.) U.S. 2,901,402 (1959) Aug. 25.

In an oil shale retorting process, improved oil recovery is obtained from the downward moving shale column through preheating and distillation zones by adding condensation nuclei formed from aluminum (titanium, aluminum, tin) chloride to the latter zone, so that oil mist condenses on the gas-borne nuclei rather than on the shale in the cooler preheating zone and can be recovered from the outlet gas.

Shale Retorting. J. W. Scott, Jr. (assigned to California Research Corp.) U.S. 2,899,365 (1959) Aug. 11.

Improved heat control is claimed in a four-zone treating device comprising a preheating zone, with superimposed gas combustion, carbon combustion and retorting zones. Shale fed to the retorting zone is devolatilized by controlled flow of gases preheated in three lower zones by the down-flowing solid residue.

8. GAS DISTRIBUTION

Compression

Sulzer Axial and Radial Blowers for the Paris Gas Supply. J. von Salis. *Gas J. 299*, 293 (1959) Sept. 16 (5 pp.)

New gas and coke works erected by Gaz de France at Alfortville, in the Parisian suburbs, employs Sulzer turbo-blowers to deliver the gas into the low-pressure distribution mains. Two blowers of axial and three of radial design, with a total capacity of 275,000 cu m/hr (162,000 cu ft/min) were originally installed. The pressure boosting station currently is being enlarged by the addition of two further Sulzer axial blowers which will bring the total capacity up to 475,000 cu m/hr or 280,000 cu ft/min. This plant makes special demands on the blowers and their control systems and it is worthy of note that axial blowers are being used in this application for the first time for handling town gas.

Distribution Systems

Data Processor for Gas Distribution Systems. A. E. Mignone. Paper DMC-59-20. New York: American Gas Association, 1959, $.25.

Growing complexity of gas distribution systems, the increasing cost of labor, the necessity for prompt and accurate load and load trend determination, and the possibility of using computers for load forecasting has prompted several companies to explore the application of automatic data logging. Unfortunately, while there are numerous articles in the technical magazines describing automatic data log-

ging and process monitoring systems, the equipments described are designed for the specific process or system and are not directly translatable to gas distribution systems. Author discusses program undertaken by Arthur D. Little, Inc., in cooperation with the American Meter Co. on the design of an automatic data logger for gas distribution systems.

Gas Dispatching. C. M. Springer. CEP-59-13. New York: American Gas Association, 1959, $.25.

Duties of a gas dispatcher, whose duty is to direct the flow of gas from its source to its destination, are outlined.

Leakage

Detection, Repair, and Prevention of Leaks in Gas Distribution Systems. G. G. Wilson, D. P. Hogan, G. K. Matus and D. A. Worcester. Project PB-30. New York: American Gas Association, 1959, $1.50.

Report previously abstracted (see *Gas Abstracts 15*, 263) is based on this brochure. This publication is a critical review of the nature of the gas distribution system leakage problem, and of currently used methods of leak detection, repair and prevention. Areas are defined in which improvements in current technology would be of greatest interest and value to the gas industry.

Novel Device Determines and Locates Gas Leaks by Sound. *Gas Age 124*, 21 (1959) Sept. 17 (2 pp.)

Electronic Leak Finder (ELF) is a compact, lightweight electronic device which is battery-operated, transistorized and easily portable. Connected to a service in the customer's home or via any other connections to a gas main, it selects and magnifies the frequency range of the sound of a leak so that the operator can not only determine that there is one but, with some practice, can approximately determine the position of the leak in the pipe. Sound is registered on a meter, and also can be picked up through earphones.

In San Diego . . . Systematic Approach Proves Practical for Leakage Mitigation and Replacement. F. G. H. Elliott. *Amer. Gas J. 186*, 18 (1959) Sept. (3 pp.)

Various methods for locating gas leaks were surveyed, such as bar hole surveys, additional patrolmen in the field, vegetation surveys by experts, isolated area pressure drop and meter tests, and manhole and substructure surveys. While, through use of these plans, numerous leaks were located and repaired, the evidence pointing to pipe replacement was not always conclusive. This was probably due to the method of recording leakage information. Ultimately, a controlled system was set up whereby leakage history of any section of the distribution piping could be properly accumulated. The system, through practical working, evolved into the one now in use. Information from this system is factual and readily available for use to determine when replacements are necessary.

Mains

Elimination of Underground Freezing Caused by Regulation. J. H. Davis. Paper GSTS-59-12. New York: American Gas Association, 1959, $.25.

Four methods are outlined that are helpful in combatting the causes or effects of frost heaving: Increasing gas temperatures; changing soil structures and or reducing moisture content; insulating underground piping, and improving piping and station design. Since the causes of frost heaving are variable in their degree of responsibility, it follows that the methods of solution also will be variable.

Metering

The Bellows Differential Gauge. G. W. Swinney. Paper GSTS-59-18. New York: American Gas Association, 1959, $.25.

After a decade of use of the bellows type meter by many companies plus continual improvements to make it a sound reliable differential pressure measuring device, it is evident that the industry has available, in addition to the mercury manometer, a type of meter which may be used for accurate measurement of natural gas. Even so, there are still speculation and doubt in the minds of many not experienced with both types as to how well the measurements made with the bellows type meter can be substantiated as correct. For these reasons it appears that the time is right for the gas industry through its organizations such as the A.G.A. Gas Measurement Committee to evaluate the use of the bellows type meters and take the necessary steps to establish that the factors and bases of measurement as outlined in Committee Report No. 3 are applicable for use with the bellows type meter on a comparable basis with the mercury type meter.

1956-57 Supplement to Bibliography of Gas Meters and Metering. J. Webb. Paper DMC-59-50. New York: American Gas Association, 1959, $.25.

Compiled by the Metering Subcommittee, bibliography cites 174 items which are classified in 25 categories.

Proving Systems for P.D. Meters. R. H. Pfrehm. *Oil Gas J. 57*, 100 (1959) Sept. 28 (4 pp.)

Design of a metering installation can, for all practical purposes, be broken down into two parts. First, the equipment to measure the volume of the stream

and second, the equipment needed to prove or calibrate the measuring equipment. Design of a meter-proving system should allow operation without having to remove the meter from service and without stopping it. Acceleration and deceleration of the meter present in a stop-start calibration places a portion of the calibration run in the low-volume area of the typical meter performance curve presented. Here the slope is the greatest, thus introducing inaccuracy in the meter factor determined. Article concentrates on the proving equipment necessary to satisfactorily calibrate meters.

The Rubber Yardstick. G. J. Sandusky. Paper DMC-59-31. New York: American Gas Association, 1959, $.25.

Author discloses the fact that a widely publicized and lauded industry standard is available but nobody uses it. Variations in meter performances, meter repair practices and proof tolerances justify the assumption that the most frequently used tool is the older customary one at hand or the rubber yardstick. Paper aims to prove necessity of replacing the yardstick and the human nervous system with transducers, servomechanisms and EDP.

Safety Aspects in the Design of Large Meter Installations. E. A. Skibinski. Paper DMC-59-18. New York: American Gas Association, 1959, $.25.

Members of the Subcommittee on Distribution Design and Development answered a questionnaire regarding safety aspects in the design of large meter installations. For this paper, a large meter was defined as a positive displacement meter, either diaphragm or rotary type, with a minimum capacity of 5000 CFH at one-half inch wc drop. Questions were related to items mentioned in the B 31.18 code as well as items not specifically included in the code. Analysis of the answers appears.

Survey of Factors Used in Classification of Meter Repairs. L. C. Baldacci. Paper DMC-59-19. New York: American Gas Association, 1959, $.25.

Fifteen companies participated in a survey, and it was found that a total of 12 distinctly different factors are considered in arriving at their classification systems. The combinations of factors used are quite varied, and the number of factors used by any one company varies from one to seven with the over-all average being four. It is not unreasonable to expect that repair classification systems would vary considerably between companies since there are many factors which determine the repair classification system used.

Odorization

Bibliography on Odorization of Gas. L. M. van der Pyl. Paper CEP-59-11. New York: American Gas Association, 1959, $.25.

Bibliography is a continuation of those presented at the 1950 and 1956 Chemical, Engineering and Production Conferences. It cites 29 items, some of which were overlooked in previous bibliographies, as well as all references that could be found since the publication of the 1956 list. Table on properties of odorants, based on data supplied by the manufacturers, is included.

Pressure Regulation

Application and Operation of the Plug Valve Regulator. Paper DMC-59-10. New York: American Gas Association, 1959, $.25.

Plug valves have been used in the gas industry for a number of years. Mainly, these valves have just been used for shut-offs but in some cases they have been used for throttling gas and in such use have proven to be quite satisfactory both from an erosion standpoint and for stable operation. About 20 years ago some gas companies started using these lubricated plug valves as pressure regulators. With the development of proper instrumentation and pneumatic and hydraulic operators, application of plug valves as controllers became more popular.

Weather Forecasting

Progress in Solar-Weather Research. W. O. Roberts and N. J. MacDonald. Paper GSTS-59-6. New York: American Gas Association, 1959, $.25.

At the present time, usefulness of knowledge of the connection between solar activity and the weather is not far enough advanced to be of practical application by long-range weather forecasters. On the other hand, there appears to be no reliable way today to make useful long-range forecasts for periods greater than 30 days ahead. Thus, the hope is that from atmospheric researches will come physical understanding leading to methods of forecasting now unknown. Some scientists believe that a real breakthrough in basic meteorological physics is required if useful long-range forecasts are ever to be developed.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Environmental Control Key to Success of the Manned Earth Satellite. H. H. Christman. *Heating, Piping & Air Conditioning 31,* 151 (1959) (16 pp.)

Discussion of factors that must be considered in

design to provide a space crew with an acceptable environment. Important ones include oxygen supply and pressurization, evaluation of the heating and air conditioning loads, and reduction of cosmic radiation. In addition to discussing each of these variables, some system design concepts for controlling each are given. In particular, some of the air conditioning systems that can satisfy the requirements of an orbital vehicle are presented.

New Formula Predicts Performance of Counterflow Cooling Towers . . . for Air Conditioning Study. W. T. Lyons. *Heating, Fiping & Air Conditioning 31,* 134 (1959) Oct. (4 pp.)

Performance of a counterflow cooling tower can be calculated arithmetically in a simple, rational and accurate manner. Article describes such a method. Purpose is not to promote the field testing of towers, but rather to show how their performance may be predicted once a set of observations at one operating condition is available. Method utilizes an equation with the test conditions properly related on the one side and equal to the predicted conditions, similarly arranged, on the other side. Thus, an unknown condition on the latter side may be calculated. Examples of use of equations are given.

Air Pollution

The Elimination of Oxides of Nitrogen from Automobile Exhaust. F. R. Taylor. (San Marino, Calif: Air Pollution Foundation Rep. No. 28, 1959, $2.00.)

Results of an investigation for a catalyst capable of inducing reduction of NO are presented. It was found that zinc-copper chromite, iron chromite, barium-promoted copper chromite and chromium-promoted iron oxides are very efficient for removing nitrogen oxides in the presence of CO or in some cases in the presence of H_2 at temperatures of approximately 220° and 320° C. It was further found that chromites also are very efficient for inducing oxidation of hydrocarbons and CO, in the absence or presence of NO, when sufficient O_2 is present. A few experiments also are presented showing the removal of NO_2, CO and hydrocarbons from actual automobile exhaust.

Smoke. How Gas Beats a Modern Menace. J. R. Teale. *Gas J. 299,* (Gas in Ind. Sect.) 206 (1959) Sept. 16 (7 pp.)

In 1946, powers were obtained by the Manchester Corp. to create a smokeless zone, but the acute fuel shortage at the time forced the Public Health Committee to postpone once more the creation of the smokeless zone until the necessary fuels would be more readily available. After a further survey in February, 1947, and after insuring that there would be adequate supplies of smokeless fuels, it was decided that on May 1, 1952, a designated "square mile" would become a smokeless zone. The date was subsequently advertised in December, 1950, in order to give the occupiers, within the proposed zone, sufficient time to meet the requirements of the Act. When the success of the central zone was assured, the Medical Officer of Health proposed an extension to the smokeless zone of approximately 130 acres.

Cooking

Food Preparation Is a Job for Mr. Therm. *Gas World 150,* (Ind. and Comm. Gas Sect.) 33 (1959) Sept. 19 (4 pp.)

Processing and preparation of food requires that the essential ingredients are not damaged or destroyed, and this can only be done by process control within very fine limits. For example, in bread making, a fermentation process, addition of water of accurate quantity and temperature is provided by gas-heated apparatus, and for the subsequent proving of the dough, strict conditions of temperature control also are necessary. The oven should be at the baking temperature of about 500° F in order to bake off the goods as they reach the oven mouth. Article discusses the application of gas in the baking industry in England.

Drying

The Fundamentals of Spray Drying. R. T. Ellington. *Ind. Gas* (Amer.) *38,* 5 (1959) Sept. (5 pp.)

Spray drying process has certain limitations, but it is particularly adaptable to the drying of heat-sensitive materials. This is possible because evaporation from each droplet in the suspension occurs at the wet bulb temperature of the drying medium as long as the particle contains moisture in excess of its equilibrium moisture content, even though the dry bulb temperature of the suspending gas is very high. The gas film around each droplet is saturated with respect to the volatile solvent, and saturation is reached essentially adiabatically using the heat of the gas in the film. After the particle is dry, its temperature can approach that of the suspending medium. Therefore, precaution must be taken to remove the particle from contact with the hot gas at the proper time. Author reviews the spray drying process, outlining its history, process attributes, equipment characteristics, the feed dispersal, evaporation from drops, air flow in driers, factors influencing design, gas firing and economics.

Ultrasonics Boosts Heatless Drying. R. M. G. Boucher. *Chem. Eng. 66,* 151 (1959) Sept. 21 (4 pp.)

Acoustic generators for industrial applications are

divided into two main categories: Electrical devices (piezoelectric, magnetostriction, electromagnetic) and the static (air-jet whistles) or dynamic sirens. Article discusses static sirens powered by compressed gases. This apparatus is well suited for drying operations. It is capable of producing intense, powerful acoustic emissions of over 1 kw, it is rugged with no interior moving parts, relatively low in cost and it provides required gas flow turbulence. Efficiency is about 20%.

Flame Research

Initiation of the Homogeneous *n*-Butane Oxidation. J. F. Skrivan and H. E. Hoelscher. *A.I.Ch.E. J. 5,* 348 (1959) Sept. (5 pp.)

Initiation of the oxidation of hydrocarbons, an important part of many flame systems, remains largely unsolved. Article reports a study of the oxidation of butane under conditions that yield information on the homogeneous initiation systems. A sequential reaction mechanism is proposed involving activation of an oxygen molecule followed by attack on a butane. This leads to rate equations which accurately describe the observed butane decomposition rates. Activation energies have been calculated from experimental data with this equation and are found to check values obtained from the literature and from theoretical considerations. The tentative initiation mechanism is used to explain the existence of three classes of products in the exit gases: Hydrocarbons other than butene, butane, and oxygenated products. Under some operating conditions periodic cool flame phenomena are observed, and their effect on the course of the reaction has been explained.

On a Study of Strong Cylindrical Shock Waves from Electrically Exploded Filaments. H. W. Liepmann and G. T. Skinner. 9th Congress Intern. Mech. Appl., Univ. Bruxelles, 1957 (3 pp.); (From *Appl. Mech. Rev. 12,* 634 (1959) Sept.)

Problem of producing high temperatures and strong cylindrical shock waves from exploding thin wires by passing a high voltage discharge through them is considered. A new experimental procedure designed to overcome difficulties in producing a very strong shock with a single discharge is outlined, and experimental work on the determination of the practicality of the method is described. Preliminary experimental work indicates that the method can be successfully applied.

M. L. Baron, USA

A Theoretical Investigation of the Interaction between Shock Waves and Boundary Layers. M. Honda. *J. Aero/Space Sci. 25,* 667 (1958) Nov. (12 pp.); [From *Appl. Mech. Rev. 12,* 633 (1959) Sept. (2 pp.)]

Interaction process between shock waves and boundary layers is treated by the author as a self-inducing type of flow, determined by an equilibrium between the induced pressure rise and the thickening of the boundary layers. On such a basis, the development of the laminar boundary layer is described by momentum and energy-integral equations, giving results to be compared favorably with known experiments. The development of the turbulent boundary layer with adverse pressure gradients in compressible fluid flow is treated semiempirically on the usual boundary-layer assumption of the incompressible flow.

A. Ghetti, Italy

Furnaces

Heating and Cooling in Continuous Furnace Closely Controls Annealed Structure for Machining. A. G. Sturrock. *Ind. Heating 26,* 1704 (1959) Sept. (7 pp.)

Description of a continuous roller hearth, cycle heating and cooling furnace used for annealing steel. Cycle heating and cycle cooling furnace is 70 ft long, essentially comprising six chambers, and heated by gas-fired radiant tubes. Vestibules at both ends of the furnace prevent escape of furnace atmosphere and infiltration of contaminating air. Furnace is designed for continuous high production and for automatic control of furnace atmosphere, heating and cooling, resulting in very uniform structure of the annealed bars.

Pilot Lights

Progress Report on Pilot Improvements. C. F. Miller. Paper DMC-59-26. New York: American Gas Association, 1959, $.25.

Objective of paper on pilot improvement is to relate what has been done by pilot manufacturers, the A.G.A. and utilities to improve the design and application of pilots for gas appliances. It is confined mostly to the replacement of the aerated type pilots with the non-linting type on gas space heating equipment.

Space Heating

HTHW District Heating at the U.S. Air Force Academy. E. G. Hansen. *Combustion 31,* 40 (1959) Sept. (8 pp.)

Prior to design of the Academy, an economics analysis indicated that 1) two gas-fired high temperature hot water (HTHW) central plants and district heating systems should be provided for heating all buildings of the large project, and 2) individual family housing units should have their own independent gas-fired heat sources. Main HTHW district heating system has a capacity of 400,000,000 Btu/hr, a maximum radius of distribution of 3-3½ miles.

Highest point in the distribution system is situated 250 ft above, lowest 250 ft below the boiler house floor. The HTHW is generated at 454° F and 440 psia. A separate 60,000,000 Btu/hr HTHW plant services the service and airfield areas. Steam pressurization is used. Circulation through the LaMont-type boilers is maintained by a separate group of pumps. Gas is the normal fuel, with No. 6 fuel oil serving as a standby. The boilers are equipped with ring-type gas burners and wide range mechanical atomizing oil burners. The fuel oil makeup system was so designed that the fuel oil is available at full capacity after a minimum of two hours' notice prior to interruption of gas service. The oil storage tanks contain a two days' supply at full boiler capacity.

Water Heaters

Gas Water Heating Equipment. Part 2. Individual Heaters. F. Lowe. *Gas Heat and Comfort Cooling 10,* 34 (1959) Oct. (5 pp.)

Author concentrates on the models of individual heaters that have been sold in the past and still are found in the field. Early remote control methods, underfired storage tank heater, horseshoe flue models, center flue models, down draft heater, coal pot conversion, conversion heaters, and preheaters are the topics discussed. Article concludes with comments on the solar box preheater.

Burners

Gaseous Fuel Combustion Apparatus. J. A. Kitchen and F. R. Denham (assigned to Lucas-Rotax Ltd.) U.S. 2,898,978 (1959) Aug. 11.

Pulsating burner is claimed comprising a mixing chamber, fed with gas and air through concentric annular inlets which are covered by spring-held valve plates, and a combustion chamber which is separated from the mixing chamber by a screened annular port which acts as a flame trap. The mixture, ignited in the combustion chamber by a periodic electric spark plug, causes a backward pressure pulsation which momentarily interrupts gas and air flow by closing the plate valve.

Gas-Fueled Burner. P. I. Hollman and L. R. Jensen (assigned to G. D. Roper Corp.) U.S. 2,898,979 (1959) Aug. 11.

In a large multiport gas burner with a number of side-wall ports, combustion at the ports is maintained at low gas input by providing an annular gas channel connecting all ports and feeding this channel through an annular gas chamber.

Pilot Lights

Flame Retention Piloting Device for Gas Burner. J. D. Holden (assigned to C. J. Gaskell Co., Inc.) U.S. 2,901,033 (1959) Aug. 25.

In a large capacity, small diameter gas burner, the flames from the ports drilled on the inner circumference of the toroidal head are stabilized and prevented from lifting in the air stream by providing smaller corresponding pilot holes spaced just below the burner ports and protected from air blast by a trough baffle.

Refrigeration

Apparatus for Gas and Liquid Cooling in Compressor Plants with Two- or Multistage Cooling Circuit. F. Wergner (assigned to CKD Stalingrad NP, Czechoslovakia). U.S. 2,897,659 (1959) Aug. 4.

Improved refrigeration efficiency is obtained and power requirements for driving the compressor are reduced by bleeding subcooled liquid refrigerant from the condensers to the suction side of the later stages of the compressor to reduce the enthalpy of the vapor-liquid mixture being handled by the system.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Sun Is Moving Ahead on Its Product-Control Center. P. D. Barton. *Oil Gas J. 57,* 128 (1959) Oct. 5 (3 pp.)

With the specific purpose of improving the quality of the information on which its plant operations are based, in December, 1958, Sun's management authorized a project to construct and equip a product control center at a 60,000 bbl/stream day combination unit at the Marcus Hook refinery. Within seven months, a three-room air-conditioned building had been completed and the installation of steam analyzers and recording instruments was progressing rapidly. This building is functionally divided into a computer and data processing room, a recorder room, and a calibration laboratory. The main control room of the 60,000 bbl combination unit is located a short distance from the control center building and most of the plant operating conditions can be monitored from this location.

Calorific Value

Calorimetric Recording. T. M. Gilbert. *Gas Age 124,* 46 (1959) Oct. 1 (2 pp.)

Recording gas calorimeters supplied for the Houston Texas Gas and Oil Corps.' metering and regulator

stations are the most precise instruments available for indicating and recording gas heating value. Because the main purpose of the Florida project was to buy and sell energy, the original contracts were drawn with the specification of heating value and volume defined, making it possible for the contracting parties to evaluate rates and services.

Computers

Computers in Research and Engineering. L. Cooper. Paper 59-SA-55. New York: American Society of Mechanical Engineers, 1959, $.80 ($.40 to members).

Computers of all kinds have found widespread application throughout the U.S. There are several thousand digital and analog computers installed and in use in various segments of industry, government and academic institutions. It seems clear that the use of computers is on a firm foundation and that their influence on society and on lives is increasing as time progresses.

Gas Turbines

How Humble Rates Its Gas Turbine. C. Bultzo. *Oil Gas J. 57,* 88 (1959) Sept. 28 (4 pp.)

Humble Oil & Refining Co.'s Baytown (Texas) refinery has in successful operation a 5000-hp gas turbine which is a simple-cycle two-shaft equipment. It drives a high-capacity centrifugal blower supplying regenerator air to a fluid catalytic cracking unit. For maximum over-all thermal efficiency, the hot exhaust gases are combined with the regenerator air after it leaves the process unit. These gases then are used to generate 600-psig steam by burning the CO in the combined stream. A heat balance has been devised to provide a method whereby field personnel can determine the performance of a gas turbine. Although operation has been satisfactory, axial-compressor and axial-compressor-turbine efficiencies have been below par. A plan has been worked out for modifications to be made during the next down time. This should result in improved efficiency and operation.

Instruments

The Hidden Helper. R. W. Bell. Paper DMC-59-8. New York: American Gas Association, 1959, $.25.

Author discusses reasons, including others than those necessary for accomplishing the job, why equipping servicemen with proper instruments is important to a company.

Instrumentation for High Pressure Gas Measurement. A. R. Kahmann. *Gas Age 124,* 48 (1959) Oct. 1 (4 pp.)

Both a balance and a gravitometer are used by the Houston, Texas Gas and Oil Corp. in determination of specific gravities. The balance is an indicating instrument operating on the principle of measuring the pressure exerted by a gas of a given density, and the pressure exerted by air of the same density, the specific gravity being determined from the ratio of the pressure measurements. The gravitometer is used to obtain specific gravities when it is desired to have a permanent record or to observe the fluctuations over a period of time without having to run frequent tests with the gravity balance.

Pumps

Design and Materials for Reduced Pump Corrosion. J. E. Piccardo. *Corrosion 15,* 473t (1959) Sept. (4 pp.)

Of the pumps used in the chemical and allied industries, about 90% are of centrifugal and diaphragm types. Diaphragm type pumps have certain advantages over centrifugal pumps for severe chemical applications because there is no shaft sealing problem, solids in suspension can be handled at relatively low velocities and a high degree of corrosion resistance can be obtained by the use of high alloy steels for the pump body and synthetic materials for the diaphragms. Both types of pumps are required to handle corrosive liquids under conditions of high temperature and pressure. Designs giving longer service life in the conventional centrifugal pump usually include the following: Improved sealing devices where the pump shaft passes through the casing, new alloys or metals for the wetted end to provide a better corrosion resistance, improved elastomers, plastics and ceramics which permit lining entire pumps for a high degree of corrosion resistance. Improved shaft seals are discussed along with a study of new materials available for pump parts, and linings for pumps commonly used in chemical pumping service.

Net Positive Suction Head. A. F. Sherzer. *Chem. Eng. Progress 55,* 79 (1959) Sept. (5 pp.)

Examination of many of the definitions of net positive suction head (NPSH) (available) as found in much of the literature involve a velocity head. In most cases this is caused by the incorrect assumption that the NPSH (available) is the same as the total head rather than the absolute pressure head. From an illustrative example presented in the article, it is clear that the final velocity of flow, V, was produced by exactly the difference at E (pipe diameter at $E = 5$ in.) and H_a (pressure of atmosphere expressed in feet of liquid). The addition or subtraction of the velocity head item would destroy this balance.

Reactors

For Gas-Phase Reactors . . . Design for Control of Temperature. F. G. Shinskey. *Chem. Eng. 66,* 143 (1959) Oct. 5 (4 pp.)

From the many categories of chemical reactions, author chooses to discuss a continuous, exothermic, gas-phase system, primarily because of the several challenges it presents to the engineer. Conclusions, based on mathematical analysis of pilot plant studies, provide a guide for design of simple, effect control for an exothermic, gas-phase reactor.

Solar Energy

Solarimeter for Field Use. J. L. Monteith. *J. Sci. Instruments 36,* 341 (1959) Aug. (6 pp.)

Using simple materials, a thermopile solarimeter has been constructed with output 5.5 mv cal^{-1} cm^{2} min^{-1}; resistance 13 Ω; response time 20 s; weight 35 g; dimensions 4 by 4 by 4 cm. It therefore can be used with a portable millivoltmeter for measuring reflexion coefficients, radiation within crops, etc. General equations for solarimeter performance and a simplified theory for the present design give a nonlinearity of —0.8% cal^{-1} cm^{2} min^{-1} and a temperature coefficient of —0.12%/°C. Outdoor comparison with a Kipp solarimeter gave ±0.03 cal cm^{-2} min^{-1} as the maximum deviation from the mean response with radiation up to 1.1 cal cm^{-2} min^{-1}. The standard deviation for 30 observations in bright sunshine and with overcast skies was ±0.002 cal cm^{-2} min^{-1}. Cosine and azimuth response were improved using a larger instrument of the same design and comparisons of this with a Kipp solarimeter gave maximum deviation of ±0.002 cal cm^{-2} min^{-1}.

Valves

Plug Valve Installations. H. Barnett. *Gas Age 124,* 54 (1959) Oct. 1 (2 pp.)

Unique feature of the Florida pipeline is the setting of the main transmission block valves. It was prefabricated in the pipe yard, and consists of one 24-in. Walworth figure 1667 WE main block valve, plus two 8-in. blow plug valves. Main line plug valves and the main suction and discharge valves are Walworth 24-in. figure 1667 WE plug valves with automatic operators. These operators allow remote control of the valves. That is, they can be opened or closed from a panel board inside one of the four compressor stations which are some distance away. Also, the individual compressor suction and discharge valves in the station are Walworth 12-in. plug valves which are all automatically operated.

Pressure Regulation

Gas Pressure Loaded Regulator. E. E. Tavener (assigned to K. Blackman, Ltd.) U.S. 2,902,047 (1959) Sept. 1.

In large industrial gas ovens, heated by groups of pressure burners spaced at considerable distances apart, control of burners and heating is attained by a diaphragm regulator, in which compressed gas loads the top of the diaphragm continuously, causing the regulator valve to open until sufficient fuel line pressure balances its setting and provides steady flow of fuel. The setting may be varied by a valve at a point convenient to the operator, which valve then can bleed off or raise the top diaphragm pressure.

Valves

Gas Water Heater Combination Control Valve. S. G. Eskin, J. M. Algino and T. B. Legeza (assigned to Dole Valve Co.) U.S. 2,898,046 (1959) Aug. 4.

Improved safety gas control valve for water heaters is claimed in which a fusible thermoelement acts to shut off gas flow at a given temperature ers is claimed in which a fusible thermoelement plunger which is rotated against a cam which controls the gas flow.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Methods of Installing Cathodic Protection Anodes for Offshore Structures. W. A. Johnson and J. T. Condry. *Corrosion 15,* 112 (1959) Sept.

New methods of installing anodes in cathodic protection systems for offshore drilling structures are given: Anodes mounted on steel pipe, anodes connected to a heavy cable that is buried in muddy bottom diagonally from the structure's corners and anodes installed in plastic tubing for protection from wave action and floating debris and for easy examination. Also, article briefly discusses operating of graphite anodes above the manufacturers' recommended current density so that a minimum number of anodes in combination with a rectifier can be used to protect a structure.

Principles and Criteria for Cathodic Protection of Steel in Sea Water. M. H. Peterson. *Corrosion 15,* 483t (1959) Sept. (5 pp.)

Development of cathodic protection is traced from the initial work of Davy to the formation of an adequate theory of cathodic protection. Techniques used in experimental determination of criteria for

protection in the laboratory and in the field are given with the advantages and limitations of each. Reference list cites 84 items.

Coatings

Coal Tar Epoxy Resin Coatings. N. T. Shideler and F. C. Whittier. Part 1. *Pipe Line News 31,* Insert 8 (1959) Sept. (5 pp.); Part 2. *Ibid,* 73 (1959) Oct. (5 pp.)

Currently there is very little difference between the industrial coal tar-epoxy resin coating and that supplied for application to pipelines except that the pipeline product is more viscous and more thixotropic to permit application of a 20-30 mil wet coating thickness in one application to pipe. Thus a discussion of either coating covers the other. Best present product is a thick, thixotropic coating that first appears too heavy for mixing; however, stirring makes the product fluid and permits incorporation of the hardener or catalyst without difficulty. Reaction with the hardener is exothermic and heat sensitive. Consequently, the pot life of the coating after addition of the catalyst is affected by the ambient temperature at the time of mixing, and by the dissipation of heat by stirring or by stirring and cooling. Tables are included to give a generalization of the normal pot life and the setting time at various ambient and metal surface temperatures.

How to Specify Protective Coatings. J. R. Allen and G. Mackey. *Petrol. Refiner 38,* 287 (1959) Sept. (2 pp.)

Authors emphasize that there are seven important points to consider before writing a protective coating specification. Also, a specification is not adequate unless provision is made to check the work to vertify that it meets the specification.

Testing and Evaluation of New Coating Materials. N. T. Shideler. Paper GSTS-59-50. New York: American Gas Association, 1959, $.25.

There is a wide divergence of the methods used by various laboratories in evaluation of present day and new coatings. This makes it difficult to correlate data or methods. Paper attempts to outline a series of test methods designed to give comparative laboratory data that may later be related to field data. At present the methods will, to a great extent, eliminate those coatings least likely to succeed when used to protect steel and steel pipe used in the transmission of gas.

Corrosion

Sacrificial Corrosion and the Relative Corrodibility of Metals. G. Fitzgerald-Lee. *Corrosion Tech. 6,* 245 (1959) Aug. (3 pp.)

Author discusses various aspects of sacrificial corrosion and refers to the relationship which exists between corrosion and electrolysis. Special attention is drawn to the considerable development of knowledge in this field since the war. Author concludes by referring to the relationship which exists between atomic number, atomic weight and corrodibility.

Inhibitors

Action of the XO_4^{n-} Inhibitors. G. H. Cartledge. *Corrosion 15,* 469t (1959) Sept. (4 pp.)

Experimental studies on the effect of ions and molecules of the type XO_4^{n-} upon corrosion of iron and steel are summarized. Measurements of electrode potentials in inhibited solutions and the effect of foreign electrolytes upon these potentials have shown the competitive and reversible nature of the surface state associated with inhibition. Studies with the pertechnetate ion as inhibitor have demonstrated absence of detectable continuing chemical action in the system over a period of more than five years. Passivation by O_sO_4 is so complete that an iron electrode indicates the thermodynamic potential of the O_s^{IV} - O_s^{VIII} couple. The Flade potential may be observed on iron electrodes in aerated, inhibited solutions without use of such vigorous passivating agents as HNO_3 or anodic polarization. Results are discussed by considering the ways in which presence of an adsorbed inhibitor may affect the kinetics of electrode processes at a metal-solution interface. Specific differences among the XO_4^{n-} particles with respect to inhibition may arise from the nature of the electrostatic field exerted by such particles over short distances.

12. ANALYTICAL METHODS AND TESTS

Analytical Instruments

Analyzers Supply Continuous E.P.-I.B.P. Data. D. H. Stormont. *Oil Gas J. 57,* 130 (1959) Oct. 5 (3 pp.)

Initial boiling points and end points of many refined products are being continuously and accurately determined by analyzers introduced in the past twelve months. The signal furnished by the instrument can be fed into a controller if automatic tower control is desired. This step has not been taken so far, however. As now used, the analyzers' output is recorded and manual controls are used to adjust the quality of the product.

(Gas Chromatography) . . . It Monitors Four Refinery Fractionating Columns. R. C. Halter and L. W. Pohler. *Oil Gas J. 57,* 135 (1959) Oct. 5 (3 pp.)

Plant-type chromatographic analyzer has been "on

stream" since late September, 1958, at the Baytown (Texas) refinery of Humble Oil & Refinery Co. It is automatically analyzing in sequence samples from each of four plant towers which are in similar service. Further, by operating the appropriate switch a process operator can cause the instrument to analyze automatically and repetitively any one of four plant samples or a standard sample, if it is desired to check calibration. Plant samples are being analyzed for isobutane and normal butane content at a rate of one analysis every ten minutes.

Simple Recording Thermobalance for Vacuum and Pressure Studies. J. G. Rabatin and C. S. Card. *Anal. Chem. 31,* 1689 (1959) Oct. (4 pp.)

New recording thermobalance is described for operations in vacuum, at 1 atm and up to 600 psi pressure of such gases as carbon dioxide, nitrogen, hydrogen sulfide, carbon monoxide, oxygen, and ammonia. Its principal features are a torsion mechanism and a photocell-light transducer system which permit easy operation at high pressures in a medium-sized pressured chamber. The new thermobalance was compared with the Chevenard thermobalance. Maximum sensitivity is about ±0.2 mg for weight changes of 100-200 mg.

Calorific Value

Studies in Bomb Calorimetry. XI—Determination of the Calorific Value of Gases; Miscellaneous. R. A. Mott and C. Parker. *Fuel 38,* 339 (1959) July (15 pp.)

Account is presented of the use of a bomb calorimeter for determining the calorific value of Calor gas (butane) and town gas. The volume of gas used can be estimated with greater precision than when using a flow-type calorimeter. The temperature rise with Calor gas can be measured satisfactorily with a mercury-in-glass bomb-calorimeter thermometer, but with town gas a resistance thermometer is desirable. It is suggested that the method should be used for determinations of the calorific value of unpurified coal gas, and as a basis for the calibration of flow-type calorimeters, which are liable to be biased. In general bomb calorimetry, recommendations are made on the heat of ignition, the nitric acid correction, the high-pressure bomb, temperature measurement, crucibles, the pressure gauge, the benzoic acid and the weighing errors. Descriptions are given of a bomb whose cap may be tightened by hand and of a timer-tapper system.

Carbon

Sealed Tube Combustions for the Determination of Carbon-14 and Total Carbon. D. L. Buchanan and B. J. Corcoran. *Ana. Chem. 31,* 1635 (1959) Oct. (4 pp.)

Conventional wet or dry combustions are associated with the formation of nitrogen oxides which even in minute amounts cause undesirable effects in proportional counters. Simultaneous microdeterminations of total carbon and carbon-14 may be performed by oxidation with cupric oxide in sealed Vycor tubes at 850° C. Manganese dioxide is added to provide free oxygen and cupric chloride displaces carbonate whenever basic metals are present. The carbon determination is as precise as it is in other types of oxidation used for carbon radioassay and the carbon dioxide is very pure as judged by its counting characteristics.

Chromatography

Determination of Argon and Methane in Gas Mixtures—Accuracy and Precision of Analysis Using a Simple Gas Chromatographic Apparatus. J. Lacy and R. V. Hill. *Chem. Ind.,* 1148 (1959) Sept. 12 (2 pp.)

Good separations of argon, methane and hydrogen have been obtained on an active carbon column at room temperature (25° C) using nitrogen as carrier gas. For the determination of argon and methane in ammonia synthesis gas, the results show good precision and accuracy using a simple apparatus. A method of analysis which would enable the concentrations of argon and methane to be determined rapidly would assist in obtaining more efficient plant control. Gas chromatographic techniques are ideally suited to such problems and in many cases can be made fully automatic.

Modification of "Agla" Micrometer Hypodermic Syringe for Use in Vapour-Phase Chromatography. J. W. Sweeting. *Chem. Ind.,* 1150 (1959) Sept. 12.

In using the "Agla" micrometer hypodermic syringe for injection of liquid samples on to the chromatographic column, it was found that the slight delay involved in injecting quantities larger than 0.01 ml often caused spreading of the peaks, which in quantitative work gave rise to errors exceeding in magnitude the normal limits. A modified micrometer barrel has been developed enabling quantities of this order to be injected instantaneously.

Coal

Determination of Hydroxyl Groups in Model Compounds, Coal and Coal Extracts. A. Halleux, S. Delavarenne and H. Tschamler. *Fuel 38,* 283 (1959) July (8 pp.)

Wide scatter of experimental results is observed when one standard example of vitrain is analyzed for hydroxyl groups by different methods. However, some measure of agreement is found between the results obtained by acetylation (in pyridine), and

those derived from trimethylsilylether formation. on a series of 20 model compounds in order to gain Acetylation was further investigated in some detail a better understanding of its scope and limitations when used on coal. Although usually satisfactory, it sometimes suffers side reactions and incomplete reaction also was observed in a few instances. Notwithstanding these difficulties, acetylation presents the advantages of reproducibility and self-consistency, when the method is applied to a series of coal extracts.

Electron Resonance Study of the Free Radicals Produced by Electrolysis of Solvent Extracts of a Coal. D. E. G. Austen, P. H. Given, D. J. E. Ingram and M. E. Peover. *Fuel 38,* 309 (1959) July (6 pp.)

Article suggests that the observed production of radicals when extracts are reduced at −2.2 v indicates the presence of naphthalene, phenanthrene or diphenyl ring systems. In contrast to the free-radical-ions produced by the electrolysis of anthracene or benzophenone, those resulting from the reduction of coal are stable at room temperature. This stability is shown to result from a low rate of proton addition and thus the observation is in line with an earlier conclusion that coals show a resistance to the addition of hydrogen.

Hydrocarbons

Analysis of Petroleum Products in the C_{12} to C_{20} Range. Application of FIA Separatory and Low Voltage Mass Spectrometric Techniques. G. L. Kearns, N. C. Maranowski and G. F. Crable. *Anal. Chem. 31,* 1646 (1959) Oct. (6 pp.)

Petroleum products in the C_{12} to C_{20} range are analyzed through a scheme employing a fluorescent indicator adsorption technique along with standard and low voltage mass spectrometry. Low voltage mass spectra of aromatics indicate a relationship between sensitivity and the number of substitutions on the benzene ring.

Isatin Tests for Aromatic Hydrocarbons and Phenols. E. Sawicki, T. W. Stanley, T. R. Hauser and R. Barry. *Anal. Chem. 31,* 1664 (1959) Oct. (4 pp.)

Methods for the detection and determination of polynuclear hydrocarbons and phenols in polluted air are badly needed. The reaction of certain isatin derivatives with phosphorus pentachloride apparently yields isatin chlorides which readily give cationic resonance dyes with phenols and polynuclear aromatic hydrocarbons. The reaction of 10 isatin derivatives with polynuclear aromatic hydrocarbons to give a hitherto unknown class of indigoid dyes absorbing at very long wave lengths has been developed into a new method for the spectral detection of the more basic aromatic hydrocarbons. As phenols and volatile hydrocarbons are not present in the neutral aromatic fraction of air particulates collected with a high volume air sampler, the isatin test procedure applied to these fractions is probably specific for the pericondensed aromatic hydrocarbons.

Mass Spectrometer

Analysis of Liquid Products from Coal Hydrogenation by Mass Spectrometry. Use of Rhenium Filaments and Low Ionizing Voltage. A. G. Sharkey, Jr., G. Wood, J. L. Shultz, I. Wender and R. A. Friedel. *Fuel 38,* 315 (1959) July (14 pp.)

Combination of data obtained with low ionizing voltage and with conventional-type analysis permits rapid comparisons of coal hydrogenation products. Molecular weights and structural types can be determined in the aromatic and saturated fractions. Type-analysis methods that are relatively independent of structural variations have been applied to these two fractions. Many structural types in the phenolic portion can be identified from two mass spectrometer runs, one on the original sample, the second on the trimethylsilylether derivative. A limited number of spectra of pure phenol derivatives, made at low ionizing voltage, indicate that a semiquantitative determination of carbon number distribution in phenolic fractions based on relative peak intensities is valid. Rhenium filaments offer much better temperature and pattern stability, particularly for analyzing samples containing large percentages of aromatics.

Nuclear Techniques

Neutron Diffraction Techniques and Their Applications to Some Problems in Physics. S. S. Sidh, L. Heaton and M. H. Mueller. *J. Appl. Phys. 30,* 1323 (1959) Sept. (18 pp.)

Neutron transmission and diffraction techniques are described with application to problems in nuclear physics, crystallography, magnetic scattering, physical structure of materials, and the liquid state. Experimental results for nuclear scattering amplitudes, positions of light atoms among heavy atoms, magnetic moment alignments in antiferromagnetic structures and diffraction of neutrons by alkali metals in the liquid state are reported. The main features of the design and operation of the neutron diffraction spectometer and the auxiliary equipment are presented.

Oxygen

Isotope Distribution in the Unterzaucher Analysis of Labeled Oxygen Compounds. W. G. Miller and

L. Anderson. *Anal. Chem. 31,* 1668 (1959) Oct. (2 pp.)

Internal distribution of oxygen isotopes has been determined in carbon dioxide obtained from enriched water by the Unterzaucher method. The finding that distribution is nonrandom is of significance in the calculation of the oxygen-18 content of samples which have been converted to carbon dioxide by the Unterzaucher method preparatory to mass analysis. A simple equation for making these calculations is presented.

Radioactivity Applications

Look at Radiation Ethylene Processing. B. G. Bray, R. A. Carstens, J. J. Martin and L. D. Thomas. *Petrol. Refiner 38,* 255 (1959) Sept. (6 pp.)

Article considers some of the problems for the design of a radiation chemical processing plant to produce polyethylene. A rough estimate has been made to give some comparative figures on the cost of polyethylene produced by the radiation and conventional processes. The estimate is only approximate because it is impossible to predict the cost of radiation. It is conceivable that so much byproduct radiation will become available that its cost will be negligible. The alternate possibility exists that a demand will develop for radiation and its cost will be comparable to that of other forms of energy. Only time can clarify the answer to this question. Meanwhile, reasonable estimates of radiation costs have been taken to show that the proposed process is competitive with the conventional processes.

Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure. Nat. Bur. Standards Handbook 69. (Washington: U.S. Government Printing Office, 1959, $.35.)

Current Handbook and its predecessors stem from the Second International Congress of Radiology, held in Stockholm in 1928. Conclusions in the present handbooks are to be considered only as recommendations of a group of experts in the radiological protection field. They carry no legal implications demanding or requiring adoption. Despite the enormous amount of work done, the problem of developing maximum permissible concentrations of radionuclides is still rendered difficult because of the relatively limited direct experience with the action of the radiation from radionuclides on human tissues. Contents of current Handbook are based on what is believed to be the best information available and it is to be expected that as knowledge increases, the numerical quantities present will be in a state of continuous modification.

Measuring Large Radiation Doses. Glass Dosimetry. N. J. Kreidl and G. E. Blair. *Nucleonics 17,* 58 (1959) Oct.; **Photographic Methods.** H. F. Nitka. *Ibid.,* 58 (2 pp.); **Luminescence Degradation.** F. H. Attix. *Ibid.,* 60 (2 pp.); **Plastic Dosimetry.** C. Artandi. *Ibid.,* 62 (2 pp.); **Microbial Monitors.** V. L. Chandler. *Ibid.,* 63 (2 pp.); **Total-Dose Standards.** S. I. Taimuty. *Ibid.,* 65 (2 pp.); **Rate Measurements.** S. I. Taimuty. *Ibid.,* 66 (2 pp.); **A Comparison of Dosimetry Methods.** P. Schall, Jr. *Ibid.,* 68 (4 pp.); **Chemical Dosimetry.** D. E. Harmer. *Ibid.,* 72 (3 pp.); **Bibliography.** *Ibid.,* 75 (2 pp.)

Special report is planned and prepared as a survey of current work on measuring large radiation doses. Experts in the field were queried on most promising systems, characteristics of these systems, and some were asked to review the kind of systems that appear to have the most promise. From their references, a large bibliography of important publications in large-dose dosimentry was compiled (136 items). Report is limited to electron and photon dosimetry; neutron dosimetry will be covered at a future date.

Nitrogen Oxides

Method of Fixing Nitrogen for Producing Oxides of Nitrogen. P. Harteck and S. Dondes (assigned to U.S.A. as represented by the U.S. A.E.C.) U.S. 2,898,277 (1959) Aug. 4.

Nitrogen dioxide and nitrous oxide, formed by ionizing reactions of nitrogen and oxygen in the air recirculated for the cooling of a nuclear reactor, are recovered respectively by cooling and condensing, then by a second stage of compressing, cooling and condensing. Pressures of 20-25 atmospheres are specified.

13. BASIC SCIENCE

Absorption

Fluid Dynamics and Diffusion Calculations for Laminar Liquid Jets. L. E. Scriven and R. L. Pigford. *A.I.Ch.E. J. 5,* 397 (1959) Sept. (6 pp.)

In connection with a study of the mechanism of gas absorption the problem arose of predicting absorption rates into laminar liquid jets. A solution to the problem is presented which provides an example of the application of fluid dynamics to the analysis of mass transfer in a complex flow system. The water jets considered issued from circular nozzles of about 1.5-mm diam., flowed intact downward through an atmosphere of solute gas at average velocities of from 75-550 cm/sec over distances of 1-15 cm, and were collected in a receiver slightly larger in diam-

eter than the nozzles. Equations describing the liquid flow near the jet surface are deduced from measurements of jet diameter and analogy to related flow situations. When these equations are used, absorption rates are predicted from unsteady state diffusion theory with the assumption of interfacial equilibrium. The predicted rates for carbon dioxide at 25° C are in close agreement with experimental determinations over the observed range of contact time of the liquid with gas, namely 0.003-0.04 sec.

Adsorption

A Precision Adsorption Apparatus for the Study of the Interactions between Gas Atoms and Surfaces. G. Constabaris, J. H. Singleton and G. D. Halsey, Jr. *J. Phys. Chem. 63,* 1350 (1959) Sept. (6 pp.)

Precision apparatus for the study of the interactions between gas atoms and surfaces of low specific area is described. A low temperature adiabatic calorimeter is used as the sample cryostat and the precise techniques of gas thermometry are used for pressure measurement. The gas is metered into the system with an accurate gas transfer apparatus. Data for the measurement of known volumes, and of the apparent volume of a vessel containing a low specific area, highly graphitized carbon black, are given. These measurements, obtained with different rare gases at various temperatures, indicate a precision of between 1 and 2 parts per 10,000. The apparent volume data are converted to the usual quantity of adsorbed volume to give room temperature adsorption isotherms at coverages of less than 2% of the monolayer.

Air

New Data for High-Pressure Air. T. H. Chadwick and P. L. Brady. *Product Eng. 30,* 71 (1959) Sept. 14 (4 pp.)

Tests conducted by the Amsterdam Institute (Holland) have extended the range of air properties for above the 100 atmospheres covered by the Bureau of Standards. Although there is still disagreement on many high-pressure properties among various groups, authors have correlated diverse data to give useful curves from 0-12,000 psi and —150° to 250° F.

Carbon

Large Molecules in Carbon Vapor. K. S. Pitzer and E. Clementi. *J. Am. Chem. Soc. 81,* 4477 (1959) Sept. 5 (9 pp.)

Molecular orbital theory is used in appropriate semi-empirical forms to predict the properties of carbon vapor. Results indicate that linear polyatomic molecules :C=C=C—C=C: are the important species. Experimental results from the literature for C_3 are combined with the calculated conjugation or resonance energies and with the heats of formation of allene and ethylene to predict heats of formation for all larger carbon molecules. It is found that the odd species have closed shell structures and lower energies than the even species but that the even species should show greater electron affinity. Both of these results are consistent with the mass spectrometric results of Honig and of Chupka and Inghram. Molecular spectroscopic data on C_3O_2 are used to estimate the free energy function increments for the species above C_3. The calculated partial vapor pressures predict C_5 to be the most abundant species in the saturated water vapor even at 2000° K with C_7 becoming comparably abundant in the 2500-3000° K range.

Clay

Acid-Base Interaction in the Adsorption of Olefins on Aluminum Kaolinite. J. J. Jurinak and D. H. Volman. *J. Phys. Chem. 63,* 1373 (1959) Sept. (6 pp.)

Interation of *n*-butane, *trans*-butane-2, 1-chloroethylene and *trans*-1,2-dichloroethylene with Na-, Ca- and Al-saturated kaolinite was investigated using adsorption and desorption techniques. Al-kaolinite was observed to chemisorb both butene-2 and 1-chloroethylene. The data support the contention that adsorbed aluminum is the site of surface acidity. Varying the degassing temperature of Al-kaolinite from 25 to 315° indicated an intimate relation between surface acidity and the moisture associated with the clay surface. Calculations suggest that the interaction with *trans*-butene-2 involves an acid-catalyzed polymerization.

Fluid Flow

Effect of Liquid on Interparticle Forces in Gas-fluidized Beds. H. W. Parker and W. F. Stevens. *A.I.Ch.E. J. 5,* 314 (1959) Sept. (5 pp.)

In an investigation of the behavior of an air-fluidized bed of glass spheres under varying interparticle forces, the results obtained are explained by hypothesizing the coexistence of particulate and aggregate fluidization. As interparticle forces are increased, a greater portion of the particles are in aggregative fluidization, resulting in a decrease in bed height. In this study water added to the fluidizing air increased the interparticle forces. Up to 0.5 mass % water was used, with a fluidized bed of glass spheres 0.013-0.035 in. in diameter. The resulting decrease in bed height has been correlated by means of a theoretical equation for the increase in interparticle forces due to the added water.

Experimental Investigation of Transpiration Cooling in Turbulent Pipe Flow. S. W. Yuan and A. Barazotti. ONR 839 16 (Polyt. Inst. Brooklyn, Aero. Lab. Rep. 479) 26 Pp. + 18 figs., (1958) Aug.; (From *Appl. Mach. Rev. 12,* 647 (1959) Sept.)

Effect of coolant air injection at the wall on the velocity and temperature distributions of the turbulent flow in a porous-wall pipe has been experimentally investigated. The experimental apparatus was designed to establish a full developed turbulent pipe flow at the entrance to a 5-in. diam. porous wall pipe test section. Main-stream Reynolds number was varied up to 300,000 for the isothermal case and corresponding weight flow for the non-isothermal case. The coolant flow to main-stream rates of 0.0008-0.018 was covered. The temperature range was between the ambient temperature and 900° F. The agreement between the theoretical results and the experimental data is found to be satisfactory. Results show that the wall-friction coefficient increases with the increase of coolant inject whereas the heat transfer coefficient decreases with the increase of coolant injection. Thus, the analog between the heat transfer and momentum transfer does not exist in transpiration cooling of pipe flow.

From authors' summary

Formation of Gas Bubbles at Submerged Orifices. W. B. Hayes, III, B. W. Hardy and C. D. Holland. *A.I.Ch.E. J. 5,* 319 (1959) Sept. (6 pp.)

Formation of air bubbles at constant pressure at submerged orifices was investigated for several liquids. The frequency of formation of the bubbles was determined by the use of a stroboscope, and the rate of gas flow was measured with conventional rotameters. Several orifices having diameters ranging from 0.0794-0.397 cm were employed, and the gas flow rate was varied from about 0.1 cc (at standard conditions)/sec to about 150 cc/sec. It was found that the formation of bubbles could be correlated with the physical variables of the system by the application of Newton's second law of motion to the bubble at the instant just prior to its release from the orifice.

Heat Transfer

Application of the Electric Analogue Method to the Problem of Radiant Heat Transfer. V. N. Adrianov. *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk Energetika i Avtomatika,* 20 (1959) Jan. (6 pp. Russian text.); (From *Appl. Mech. Rev. 12,* 647 (1959) Sept.)

Two integral equations which describe the process of radiant heat exchange in a closed system of surfaces with the absorbing and scattering medium present in an enclosure are shown to be sufficiently approximated by a system of linear algebraic equations. This scheme is equivalent to the solution of electric networks as first suggested by Oppenheim. The problem is extended by the author to the case when the gas present in the enclosure is not at a constant temperature; however, the problem is still restricted to diffuse radiation from enclosing surfaces. An electrical analog is given in the paper for the solution of the integral equations of radiant heat transfer with the help of an electrical integrator, but no specific problems are solved.

R. Viskanta, USA

The Detection of Thermal Radiation Using Linear Expansion. R. V. Jones. *Proc. Roy. Soc. Lond. 249,* 100, (1959) Jan. (14 pp.); (From *Appl. Mech. Rev. 12,* 647 (1959) Sept.)

Thermal radiation detector is described which depends on the expansion of a thin metallic strip a few millimeters long. Expansions of the order of 10^{-12} to 10^{-10} cm are converted into rotations of 10^{-10} to 10^{-8} radians by means of a mechanical system using a galvanometer-type suspension strip as a flexure pivot. The rotations are measured with an optical lever and photoelectric amplifying system. Constantan 0.1 micron thick is employed as the expansion material, and the receiving area is about 1 mm^2. The device was developed primarily to see whether the thermal fluctuation limit of sensitivity could be more closely approached than with conventional detectors. Observations on several of the best of the expansion devices show that they come within a factor of between two and three of the best possible sensitivity for a receiving area of 1 mm^2, achieving a noise equivalent signal of less than 1.5×10^{-11} watts for a bandwidth of 1 cycle/sec. In its present form the instrument is not very practical, but may possibly be improved.

From author's summary by C. F. Bonilla, Puerto Rico

Heat Emission in Pipes During Laminar Flow of a Liquid with Axial Heat Conduction Taken into Account. D. A. Labuntsov. *Soviet Phys.-Dokladi 3,* 33 (1958) Dec. (3 pp.); Trans. of *Dokladi Akad. Nauk SSSR (N.S.) 118,* 1118 (1958) Jan.-Feb. (3 pp.) by Amer. Inst. Phys., Inc., New York; (From *Appl. Mech. Rev. 12,* 645 (1959) Sept.)

Analysis assumes parabolic velocity distribution in circular pipe and physical properties to be independent of temperature. Constant wall temperature case and constant wall-heat-flux case were considered. For former case, Nusselt number was shown to be a function of Peclet number with results tabulated for Pe^2 from 1 to 10^4. In latter case, Nusselt number is not dependent on Peclet number and

remains equal to the constant value 4.36. Reviewer found treatment very sketchy and difficult to follow. Little discussion or references to other work are given. Development does not appear to parallel classical solutions for nonaxial conduction, although constant flux result is identical to limiting value given by other investigators.

A. Sesonske, USA

Heat Transfer in Non-Newtonian Laminar Flow in Tubes. J. Schenk and J. van Laar. *Appl. Sci. Res. (A) 7,* 449 (1958) (14 pp.); (From *Appl. Mech. Rev. 12,* 646 (1959) Sept.)

Cup mixing mean temperatures and local Nusselt numbers are presented for a fluid obeying the Prandtl-Eyring stress-strain rate formula. Previously unreported data are the first two eigenvalues, eigenfunctions and Fourier coefficients for two values of sider the influence of thermal resistance of the wall a velocity profile parameter and only the lowest eigenvalues for five other values. Authors con- on the fully developed inside Nusselt number. An analysis of the effect of frictional heat dissipation is given in the appendix.

E. H. Wissler, USA

Heat Transfer Engineering. H. Schenck, Jr. (Englewood Cliffs: Prentice-Hall, Inc., 1959.) 310 pp. $9.25.

This textbook, written for the undergraduate student, gives a brief but lucid "building block" approach to heat transfer, and introduces problems from nuclear technology for the modern student. The discussion of steady state conduction includes various shapes and resistances, with analytic solutions, source and sink solutions, flux plots, relaxation nets and electric analogies. An adequate but briefly treated range of topics is presented on natural and forced convection. Dimensional analysis, Reynolds analogy, J-factors, laminar flow cases, tube entrance effects, liquid metal cases, tube banks and complex surfaces are discussed. Transfer by radiation is somewhat slighted compared to other recent texts. The basic phenomena, geometric relationships and the resistance network analog are discussed adequately. Unsteady state conduction with convection includes treatment of the rate equation, the Gurney-Lurie and Heisler/Hottel charts, and electric and hydraulic analogies. The Schmidt method and relaxation net complete the chapter. Combined transfer problems taken up include the thin rod, fins, non-uniform fins and over-all coefficients. Others are boilers and condensers, heat exchangers, the transfer unit, the operating line-equilibrium line method, propulsion and reactor systems and heat pumps. Much of the responsibility of developments is left to the instructor. The discussions are brief but should give the first reader a good appreciation of the field. The final chapter, on heat transfer testing, is a bit out of the ordinary. It should be of value to the student in explaining experimental techniques.

The Radial Flow of Heat in an Infinite Cylinder. T. P. Newcomb. *Brit. J. Appl. Phys. 9,* 456 (1958) Nov. (3 pp.); (From *Appl. Mech. Rev. 12,* 645 (1959) Sept.)

Solution is given to the transient flow of heat in an infinite circular cylinder with the boundary condition on the cylindrical surface specified as a linear function of time. The practical application of the result is cited as occurring with a band brake with which a moving vehicle is decelerated. Excellent agreement is obtained between an experiment and an analytical computation for flow of frictionally generated heat into a brake lining and a brake drum. The analytical computation makes no use of the cylindrical solution, as it removes the curvature effect by its approximations and reduces the solution (now applicable to both the inner drum and the brake lining) to the solution for the flow of heat in a semi-infinite solid contained in Carslaw. One would expect a good geometical approximation to a brake band-brake drum system to be that of two parallel slabs with frictional heat generated at their interface.

E. V. Somers, USA

Wall Heat-Flow Measured with Large Scale Apparatus. R. K. Solvason. *ASHRAE J. 1,* 38 (1959) (5 pp.)

Built-up 8 by 8 wall sections can be tested to determine heat transmission coefficients under steady-state conditions; also, with a periodic variation in cold side temperature. Definitive review of special apparatus developed for the purpose is presented, together with a review of earlier and present design criteria.

Heavy Water

Production of Heavy Water. W. P. Bebbington and V. R. Thayer. *Chem. Eng. Progress 55,* 70 (1959) Sept. (8 pp.)

Engineering details of the "Spevack" process for the production of heavy water by dual temperature exchange using hydrogen sulfide. Process, known as the GS process, is in use at both the Dana and Savannah River heavy water plants. Process is used only for the extraction of D_2O from natural water and its concentration to 15-20%. The GS process is in no sense limited to this percentage as a maximum. For reasons of operating convenience, dependability, and flexibility, simpler processes were selected for the final concentration. These processes,

vacuum distillation to 90-25% and electrolysis to 99.8%, although less efficient in their use of energy, operate on such small volumes of concentrate that they contribute negligibly to cost.

Hydrogen

Electrode Potentials of the Palladium+Hydrogen System. T. B. Flanagan and F. A. Lewis. *Trans. Faraday Soc. 55,* 1409 (1959) Aug. (8 pp.)

Electrode potential of palladium as a function of hydrogen content has been measured between (H)/(Pd)=0 and (H)/(Pd)=0.69 during absorption of hydrogen from acidic solutions. Over this range of concentration the free energies of solution of hydrogen in palladium calculated from electrode potentials closely parallel those calculated from gas-phase isothermal data. No support can be given to a previously suggested free-energy difference between electrolytically prepared and gas-phase saturated palladium hydrides.

Hydrogen Absorption by Palladium in Aqueous Solution. T. B. Flanagan and F. A. Lewis. *Trans. Faraday Soc. 55,* 1400 (1959) Aug. (9 pp.)

Course of adsorption of hydrogen by palladium has been studied in aqueous solutions using cold drawn and annealed wire specimens. The final volume of hydrogen absorbed from solution is found to be equal to the equilibrium concentration reported for direct absorption from the gas phase. Factors influencing the approach to equilibrium have been investigated. The progress of absorption of hydrogen was followed by measurement of changes in the relative resistance of the specimens. The relation between hydrogen content and relative resistance was reinvestigated for the palladium used in this work. Under the conditions employed, processes at the palladium surface are the determining factors in the absorption of hydrogen.

Mass Transfer

Some Aspects of Fluid Mechanics in Chemical Engineering. B. H. Sage. *A.I.Ch.E. J. 5,* 331 (1959) Sept. (8 pp.)

Prediction of the transfers of momentum, energy, and material is of ever-pressing concern to the engineer interested in process design. Recently developed facts concerning the transport of momentum which are of particular use in predicting transfer of energy and material are reviewed, as well as the background of thermodynamics associated with transport processes. The more elemental relationships pertaining to thermal and material transfer in flowing streams are considered, and some of the interrelations of the transport processes are presented.

Mathematical Methods

Dimensionless Numbers. D. F. Boucher and G. E. Alves. *Chem. Eng. Progress 55,* 55 (1959) Sept. (10 pp.)

Use of dimensionless numbers or groups of variables in the various branches of engineering is expanding rapidly. Article presents a tabulated list of dimensionless numbers now in use in fields of interest to chemical engineers. List provides name, formula, significance, area of use, and source references for each of these numbers. In addition to its use as a reference, tabulation may assist in proper labelling of coefficients in non-dimensionalized differential equations, and to facilitate proper selection of groupings that arise in model and scale-up studies. In the latter connection, if all the variables affecting a particular operation are known, dimensional analysis can be employed to indicate the groups of variables that are significant. Number of experiments needed in a model study thus is reduced by dimensional analysis, since only the effect of each grouping need be explored rather than the effect of each individual variable.

Phase Equilibria

Applied Hydrocarbon Thermodynamics. Part 13. Equilibrium Flash Vaporization Correlations for Heavy Oils under Sub-Atmospheric Pressures. W. C. Edmister and K. K. Okamoto. *Petrol. Refiner 38,* 271 (1959) Sept. (10 pp.)

Empirical methods of predicting phase relationships in the vacuum region for high boiling petroleum fractions are presented. These are based on experimental data, some from the literature and some new data. A method has been developed relating the 10 mm ASTM D 1160 and ASTM D 158 distillations from a number of experimental data on gas oils. With the ASTM D 1160 "Reduced Pressure Distillation of Petroleum Products" used as a control method on heavy, high boiling petroleum fraction, it is desirable to develop correlations for predicting EFV and TBP distillations from a simple analytical distillation. A correlation has been developed for the temperature-pressure relationship of the EFV 30% and 50% points in the vacuum region. Phase diagrams for petroleum fractions above atmospheric pressure can be constructed satisfactorily by use of the focal point method.

Effective Collision Diameters and Correlation of Some Thermodynamic Properties of Solutions. J. M. Prausnitz and P. R. Benson. *A.I.Ch.E. J. 5,* 301 (1959) Sept. (3 pp.)

Volumetric data on gas mixtures and vapor-phase data for gas-liquid equilibria have been correlated within the framework of the theory of corresponding

states. An expression based on the London potential for dispersion forces was used to compute characteristic temperatures for various binary systems, and a correlation was developed relating these temperatures to the polarizabilities, ionization potentials, and critical volumes of the pure components. The correlation shows how the molecular shape of a liquid affects its vapor-phase solubility. With the help of this correlation, it is possible to make very good predictions of such gas-liquid equilibria as are required in high-pressure distillation, absorption, and petroleum hydrofining operations.

Ideal K's for Acetylene. D. S. Hoffman and J. H. Weber. *Petrol. Refiner 38,* 285 (1959) Sept. (2 pp.)

In the production of acetylene from light hydrocarbons it is necessary to separate the acetylene from other reaction products and unreacted feed materials. The separation processes involved are usually distillation, absorption, and stripping. To design units for any of these purposes, a knowledge of the ideal K's for acetylene is useful. Article presents ideal K values for acetylene over the temperature range —114.9° to 97.4° F, and up to pressures of 1000 psia.

Propane

Liquid, Gas and Dense Fluid Viscosity of Propane. K. E. Starling, B. E. Eakin and R. T. Ellington. (St. Paul, Minn., A.I.Ch.E. Symposium on Physical Properties of Liquids, Sept. 27-30, 1959.) Preprint 23 (31 pp.) $.50.

Experimental data are presented for the viscosity of propane at pressures of 100-8000 psia for nine temperatures from 77°-280° F. These data were combined with the available literature values to prepare a "Table of Recommended Viscosity Value" with maximum uncertainty of ±2% for temperatures from 70°-460° F. Comparisons are made of the recommended values with two generalized correlations and with the Enskog viscosity theory for dense gases.

Some Features of the Oxidation of Propane and Ethane at 318° C. J. H. Knox. *Trans. Faraday Soc. 55,* 1362 (1959) Aug. (13 pp.)

Analytical and kinetic evidence is presented, including data on the duration of the induction period, τ, the acceleration constant, ϕ, and the maximum rate of pressure rise, ρ_{max}. Interpretation of the measurements of τ is shown to be extremely difficult and even that of ρ_{max} sometimes open to question. It is concluded that the most useful parameter is ϕ. Theoretical relations for the dependence of ϕ on reactant concentrations are shown to be obeyed by the oxidations of ethane and propane, and from them it is concluded that the lifetimes of the branching intermediates in these oxidations are approximately 2 and 1 min respectively. The results also indicate that only very few molecules of these intermediates are formed by each complete reaction chain. This conclusion agrees with the analytical data which show that the main chain reaction removing propane is similar to that occurring at high temperatures (i.e., an HO_2 radical chain forming propylene as its major product) and one which does not itself form any branching intermediate. The propylene so formed is, however, itself oxidized and reaches a maximum concentration. This secondary oxidation adds to the complexity of the reaction and causes additional acceleration.

Solubility

The Solubility of Mercury in Gases at High Density. M. J. Richardson and J. S. Rowlinson. *Trans. Faraday Soc. 55,* 1333 (1959) Aug. (5 pp.)

Measurements are reported of the solubility of mercury in *n*-butane at temperatures of 215, 256 and 300° C, and at pressures up to 400 atm. The concentration of mercury is found to exceed that calculated from the saturated vapor pressure by factors of up to 3.7. The critical end-point temperatures of the systems mercury + cyclohexane and mercury + *o*-xylene have been measured. The latter is 0.4° C below the critical temperature of the pure hydrocarbon. Critical temperatures cannot, therefore, be reliably measured in the presence of excess mercury at temperatures above about 300° C.

Thermal Conductivity

Thermal Conductivity of Diatomic Gases: Liquid and Gaseous States. C. A. Schaefer and G. Thodos. *A.I.Ch.E. J. 5,* 367 (1959) Sept. (6 pp.)

After an extensive literature survey the experimental thermal-conductivity data for twelve diatomic gases were utilized to produce an accurate and expedient means of predicting values over extensive ranges of temperature and pressure. Plotting values of k^* against T_r on logarithimic coordinates produced similarities pointing to the existence of corresponding states behavior for this family of substances with the exception of hydrogen. Because hydrogen cannot be included in a correlation generalized for the diatomic gases, it has been eliminated from this study. Based on atmospheric pressure data, ratios of k^*/k_{Tc} produced a unique relationship with reduced temperature. To include the effect of pressure, residual thermal conductivities were correlated with density for nitrogen and oxygen, the only substances for which high-pressure data exist. These relationships enabled the determination of the thermal conductivity at the critical point.

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